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Meeting Increased Load Demands

LARGE HYDRAULIC ELEVATOR PUMP AND MODERN AIR CONDITIONING AND SEWAGE DISPOSAL APPARATUS ADDED TO POWER-PLANT EQUIPMENT OF BOSTON STORE, CHICAGO

THOSE WHO WERE FAMILIAR with Chicago during the early eighties can undoubtedly recall the comparatively small 4-story department store located on the south side of the alley between Madison and Washington Sts. Here, under the firm name of Partridge & Netcher, was laid the foundation for one of the city's popular mercantile establishments, the Boston Store. Phenomenal as has been the growth and development of Chicago, in step with it has been the growth and development of the Boston Store.

Responsive to the necessity for larger and more commodious quarters, the management has acquired additional property, until with its 17 stories above the sidewalk and its basement and 2 sub-basements below the street level, the building covers the entire half block.

Development of the power plant serving this estab-

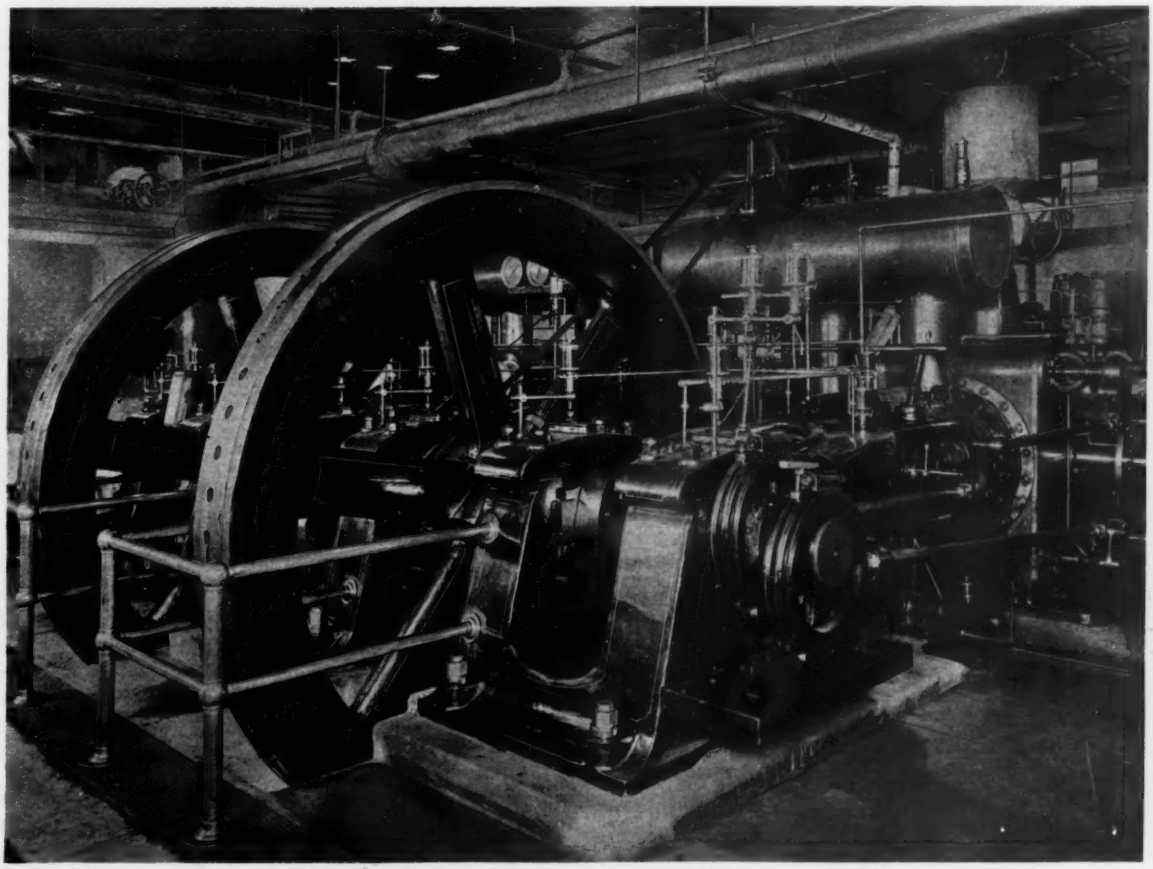


FIG. 1. PUMP FOR OPERATION OF ELEVATORS, ONE OF THE LARGEST EVER CONSTRUCTED FOR THAT SERVICE

lishment with light, heat, power, elevator service, refrigeration and ventilation is as interesting as the development of steam power plant engineering itself. The original store, now called section 5, had a plant consisting of 1 75-kw. Ball & Wood-Western Electric and 1 75-kw. and 2 150-kw. Ball-Western Electric direct-connected generating units, supplied with steam by 2 375-hp. Heine boilers. With section 1, lying midway between North State and North Dearborn Sts., another sources of energy generation to serve a single establishment, the management at the suggestion of Anton Jaggle, chief engineer, made plans for the installation of a central power plant, which was placed in operation during the latter part of 1905. And while ample provision was at that time made to meet a considerable increase of load, it was found necessary to increase the capacity of this plant again at the time the last store addition was placed in service.

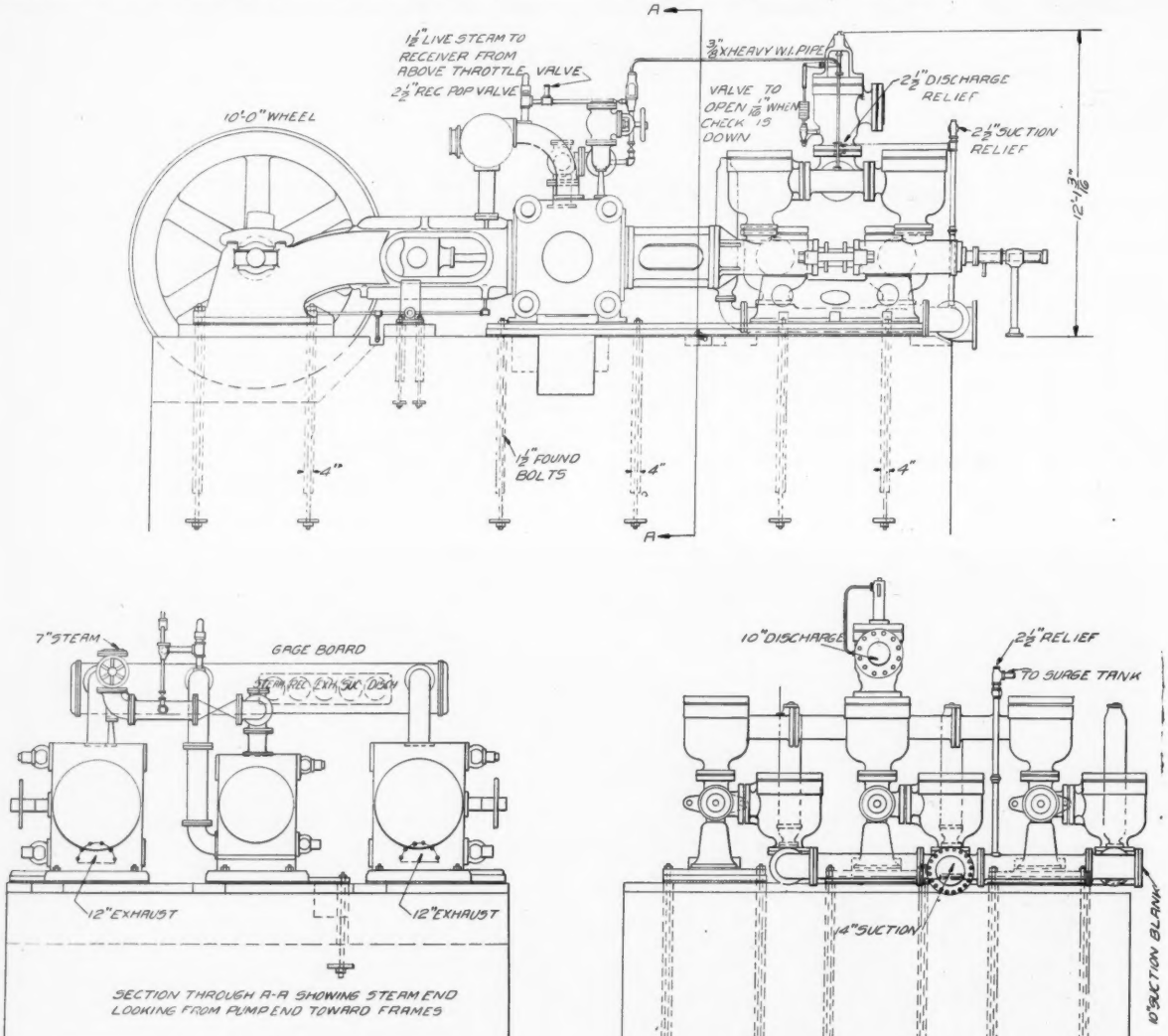


FIG. 2. ELEVATION OF SECTIONAL VIEWS, LAIDLAW-DUNN-GORDON ELEVATOR PUMP

plant, containing horizontal tubular boilers and 2 250-hp. Phoenix high-speed engines belted to Western Electric High-Tension Arc and Mather Incandescent Dynamos, was acquired. The third plant, that in the basement of the Champlain Building, consisted of a single 100-kw. Western Electric generator direct connected to an Ideal Engine. That part of section 4 lying along North Dearborn St. was supplied with service by the local lighting company.

Realizing the enormous operating expenses and resulting low efficiencies due to the maintenance of 4

As evidence of the saving effected due to the erection of the new plant with the present load of over 10 times that carried by the 3 original plants, the fuel consumption is no greater today than then.

The Steam Generators

Five Heine water-tube boilers, 2 of which have a nominal rating of 500 hp., and 3 a rating of 375 hp., supply all steam needed for the engines, pumps, heating, laundry, restaurant, lunch-room and kitchen service; in addition, the Merchant Marine Building, a 4-story struc-

ture, is also served with steam heating. These boilers, which operate under a gage pressure of 150 lb. per square inch, are equipped with McKenzie chain grate stokers and Foster superheaters, superheating the steam 80 deg. F. They are further equipped with Ashton pop safety valves and Everlasting blowoff valves of which there are 2 on each branch connecting with the blowoff main; this main empties into a cooling basin approximately 2½ ft. in diameter and 5 ft. deep from which the discharge from the boilers is taken by an ejector and delivered to the city sewers.

Water for boiler-feed purposes is obtained from the city water mains, and together with the returns is passed through a Cochrane open feed-water heater and fed to the boilers by one of 3 duplex steam pumps located in the engine room. Two of these pumps have dimensions of 14 by 8½ by 12 in., and are of Snow make, while the third, a 10 by 6 by 12-in. unit, is of Blake-Knowles manufacture.

Due to the limited available floor space and low head room, the installation of coal bunkers or bins was found impracticable, and as a result, the coal, part of which is delivered to the plant by trucks and the remainder by the cars of the Chicago Tunnel Co., upon delivery is wheeled and dumped into the stoker hoppers. The fuel is primarily screenings, of which an average of 55 to 60 tons a day are burned.

Engine-Room Equipment

According to the layout of the engine-room equipment, it was evidently the plan of the designer to group the machines according to their respective class and in a manner enabling the ready repair of existing equipment and the installation of additional equipment with the least possible inconvenience and interruption to operation.

Current for light and motor power is supplied by 2 300-kw. Western Electric-Fleming 4-valve cross-compound units, 1 200-kw. Western Electric-Fleming 4-valve simple unit, 1 100-kw. Western Electric-Ideal unit and a recently-installed 750-kw. Allis-Chalmers generator direct connected to a 30 and 46 by 42-in. cross-compound Corliss engine of the same make running at a speed of 100 r. p. m. Its flywheel is 17 ft. in diameter and weighs 70,000 lb.

Prior to the erection of section 6, the original installation of elevator pumps consisting of 2 18-30-7¾ by 24-in. Prescott pumps and 1 25-30-30-65/16 by 24-in. Laidlaw-Dunn-Gordon pump was sufficient to meet all demands placed upon it. Additional elevators, however, making a total of 42 for all classes of service and having a combined lifting capacity of 146,000 lb., necessitated the purchase of a pump of sufficient capacity to handle the entire load. This pumping engine, shown in Figs. 1 and 2, and said to be one of the largest ever applied to this particular class of service, was placed in operation during the month of August of the present year. It is of the 3-cylinder compound crank and flywheel type and was built at the Laidlaw-Dunn-Gordon Works of the Worthington Pump and Machinery Corporation.

At its full-rated capacity, namely, 1100 gal. per minute and with a maximum water pressure of 850 lb. per square inch, the engine develops approximately 550 hp. The steam cylinders are proportioned to accommodate pressure of from 125 lb. to 140 lb. per square inch, and are fitted with Corliss valve gears, those on the high-pressure side being of the full releasing type while those on each of the 2 low-pressure cylinders are of the nonreleasing type. Because of this design and the relatively large cylinder ratio employed, the steam economy of the pump is claimed to be extremely high.

The 3-cylinder arrangement renders this pump entirely automatic in action; that is not only does it operate at varying speeds and capacities but also comes

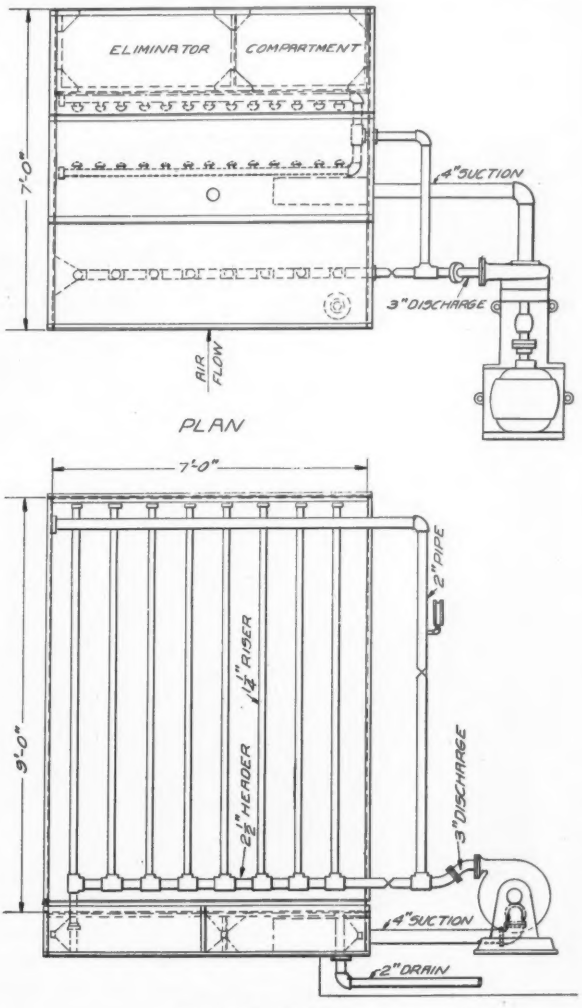


FIG. 3. PLAN AND SECTIONAL VIEW OF AIR-WASHING UNIT

to a full stop when all elevators are temporarily out of service, and again automatically starts with the starting of an elevator.

The automatic governing mechanism, as may be seen from a study of Fig. 2, consists primarily of a chronometer valve, a speed governor, a check valve in the pump discharge, an automatic relief valve for the pump end and an automatic bypass for admitting live steam to the low-pressure cylinders. The chronometer valve is controlled by means of a pulley arrangement acting on the accumulator. At the extreme low position of the

accumulator, when the demand for water is greatest, the chronometer valve is wide open and at the extreme high position of the accumulator, that is, when the demand for water is nil, the chronometer valve is closed. When the unit comes to rest, the check valve in the discharge line, of course, closes, and in doing so opens a small relief valve attached in the pump end below the discharge valves, so that the working pressure against which the pump normally operates is removed from the plungers. At the same time, a steam bypass valve connected below the chronometer valve opens communication between the steam line and the low-pressure cylinder.

Since, while the pump is at rest, no steam can pass the chronometer valve, none will be admitted to the low-pressure cylinders until the chronometer valve opens as the accumulator begins to fall. This small amount of steam admitted to the low-pressure cylinder together with that admitted to the high-pressure cylinder through the main steam line is sufficient to start the pump regardless of the position occupied by the cranks at the time of coming to rest. When the pump again starts, the check valve in the water line opens bringing about the closure not only of the bleeder on the pump end, but also the steam bypass to the low-pressure cylinders.

The water end is of the pot-valve chamber type, separate chambers being used for suction and discharge valves.

Auxiliary elevator equipment consists of 3 45-ton Otis accumulators, a 10 by 7 by 12-in. simple duplex and an 8-12-7 by 12-in. compound duplex Prescott pilot pump.

Of the 42 elevators mentioned above, 27 are for passenger service, 7 for package and freight service, 2 are van elevators and 6 are sidewalk lifts. Eleven of the passenger cars have a capacity of 4000 lb. each and 16 a capacity of 3500 lb. each; the freight elevators are rated at 2 tons each and the van and sidewalk lifts at 5 and 1 tons respectively.

To conform to a local ordinance prohibiting the parking of vehicles in the streets and alleys of Chicago's loop district for more than a limited period of time, a unique method for the handling of delivery wagons and trucks is employed. Shipping and receiving departments for all goods except furniture are in the sub-basement, where by means of the 2 5-ton van elevators, the wagons and trucks are brought for loading and unloading; furniture is in like manner received at and shipped from the 14th floor.

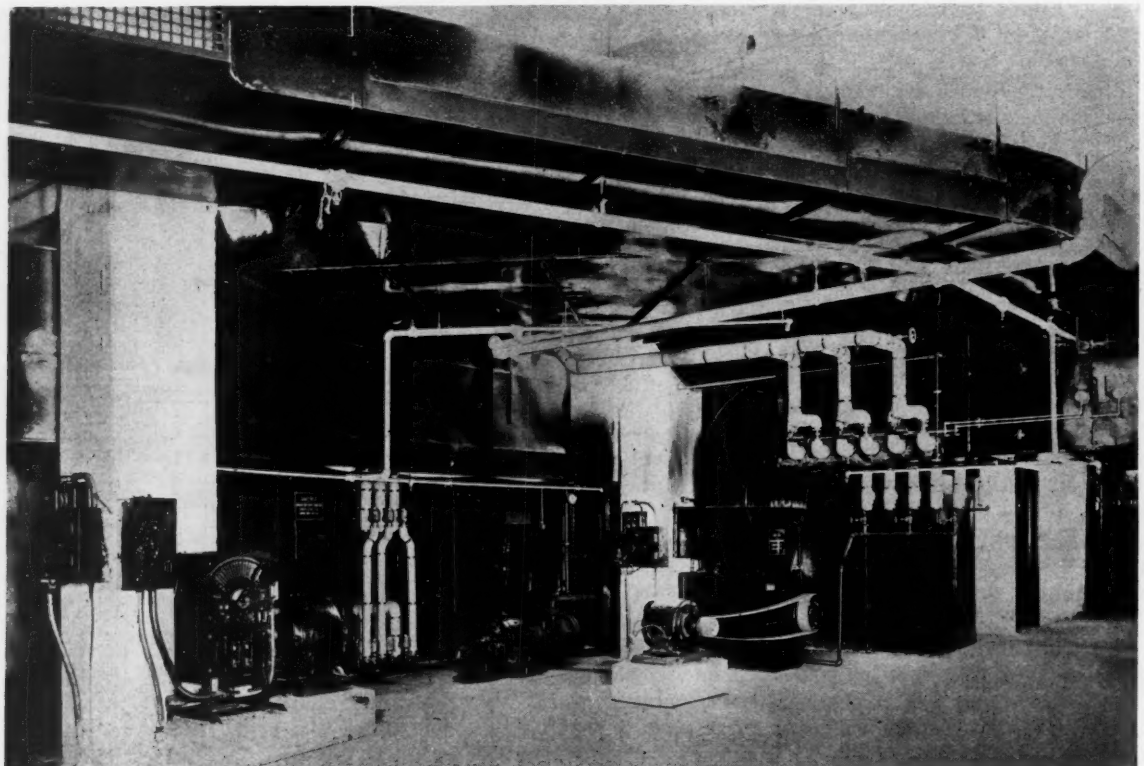


FIG. 4. VIEW SHOWING PART OF AIR-WASHING EQUIPMENT

Ventilation and Air Conditioning

As the health and usefulness of employes forced to work in otherwise poorly ventilated basements and sub-basements is greatly dependent upon an abundant supply of fresh and properly humidified air, it is essential that provision be made for such. A complete and modern ventilating and air-conditioning equipment built by the B. F. Sturtevant Co. has, therefore, been installed in the third basement of section 6. This equipment consists of 3 air washers known as Units 1, 2 and 3 serving

the second floor, main floor and basement, and second and third basements respectively; one fresh air fan provided with tempering coils and furnishing the various entrances with air at the desired temperature; and 3 exhaust fans designated as Units 6, 7 and 8 used to serve the sub-basements, the first basement and the main floor respectively. Each exhaust fan is designed to handle 10,000 cu. ft. of air per minute and is driven by a 5-hp. Sprague direct-current motor.

Air washing unit No. 1, plan and end elevation of which are shown in Fig. 3, has a capacity of 27,000 cu. ft. per minute with the fan running at a speed of 204 r. p. m. The motor driving the fan is a 15-hp. Sprague direct-current machine and the one driving the centrifugal pump a 7½-hp. motor of the same make.

The casing housing the sprayers, washers, eliminators and reheating coils is built up of No. 20 galvanized steel 7 ft. long, 9 ft. high and 7 ft. wide. The tank which not only holds several thousand pounds of water but also the weight of the casing, eliminators and diffuser plates, is built up of plates of approximately No. 14 gage. All

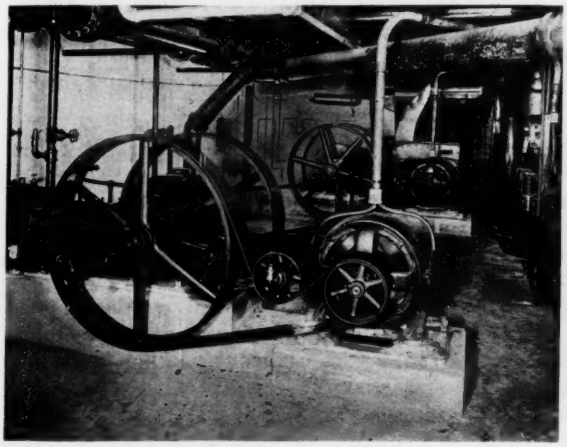


FIG. 5. AIR COMPRESSORS AND ELECTRICAL CONTROL BOARD, SEWAGE DISPOSAL EQUIPMENT

doors, connections, seams and joints are soldered and riveted with ¼-in. rivets having a maximum pitch of 5 in. and to insure water tightness, all rivet heads are covered with solder; 1½ by 1½-in. angle irons, also galvanized, are employed for bracing both tank and casing.

To prevent dirt washed from the air reaching the pump and spray nozzles, a straining device consisting of a compartment extending the full width of the tank and fitted with fine mesh copper screens is provided. The frames of these screens are held in place by galvanized guides and are fitted with handles allowing their removal for cleaning.

Even if the fan is not in operation, the atomized water is entirely retained within the spray chamber by means of a series of diffuser plates placed across the front of the spray chamber. And, in addition, to prevent "back splash" these plates serve the purpose of distributing the air uniformly and maintaining equal velocities through the spray chamber.

The eliminator plates, which in addition to their function of removing moisture also act as a washing surface for the removal of dust which may impinge upon them, are arranged in tiers. Their projecting lips cut the air into a multitude of streams, bringing all of it in contact with the wet surfaces upon which any dirt remaining in the air is deposited.

The atomizing nozzles screwed into 1¼-in. risers and spaced as shown are placed about 4 ft. in front of the eliminators. In addition to this main spray, there is an auxiliary spray pipe placed across the top of the spray chamber adjacent to the eliminators and fitted with nozzles of the rain-spray type, placed 6 in. apart and supplying 5 gal. of water per minute to each foot of eliminator width.

The recirculating pump is of the double-suction enclosed-impeller split-casing type direct connected to a 7½-hp. motor, and has a 4-in. suction and a 3-in. discharge feeding a 2½-in. header to which the spray risers are attached.

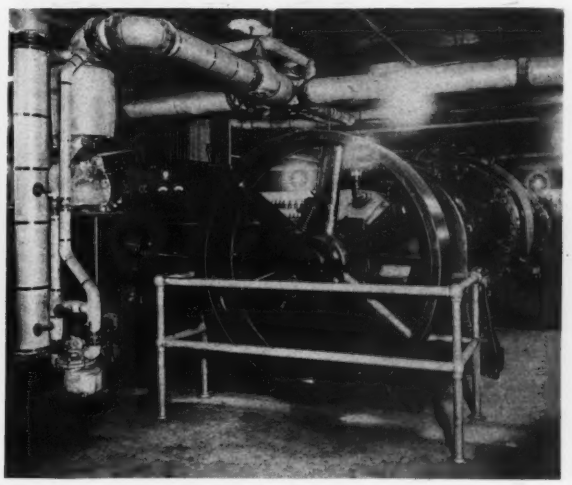


FIG. 6. ORIGINALLY-INSTALLED ELECTRIC GENERATING UNITS

Constant water level is maintained in the tank by a fresh-water supply valve operated by a ball float. And to carry away surplus water, the tank is fitted with a conical-shaped overflow and trap which eliminates any possibility of the fan drawing odors and sewer gases from the drain pipe into the spray chamber.

Units Nos. 2 and 3, which have rated capacities of 22,000 and 12,000 cu. ft. of air respectively, are built upon the same general lines as No. 1. Unit No. 2 has an air inlet of 48 sq. ft., and is equipped with a 15-hp. Sprague fan motor and a 7½-hp. Sprague pump motor; Unit No. 3 has an air inlet of 28 sq. ft. and is equipped with 7½-hp. Sprague fan motor and a 5-hp. pump motor of the same make. Fan and pump motors are controlled by Cutler-Hammer apparatus, and each unit has 2 tempering coils thermostatically controlled.

Sewage Disposal

Another problem of vital importance wherever the lower floors of a building are below the level of the city sewers is that of sewage disposal. In this installation,

the sewage from all floors above the street is discharged into the city sewers while that from the basement and sub-basements may be handled by any one of 3 distinct disposal systems, all of which are, however, inter-connected to allow flexibility of operation. One of these systems, but recently installed, is in the basement of section 6; the other two, one consisting of two centrifugal pumps each direct connected to a 10 by 12-in. Lawrence Machine Co.'s vertical high-speed steam engine and used only for emergency service and the other consisting of 2 Yeomans sewage disposal pumps, each having a capacity of 400 gal. per minute and driven by a 9-hp. Jenney direct-current motor controlled by an automatic float arrangement, are in the engine room.

That in the sub-basement of section 6 is of the Shone System and while primarily intended to serve this building exclusively, it is of sufficient capacity and so interconnected with the house sewer that it can readily care

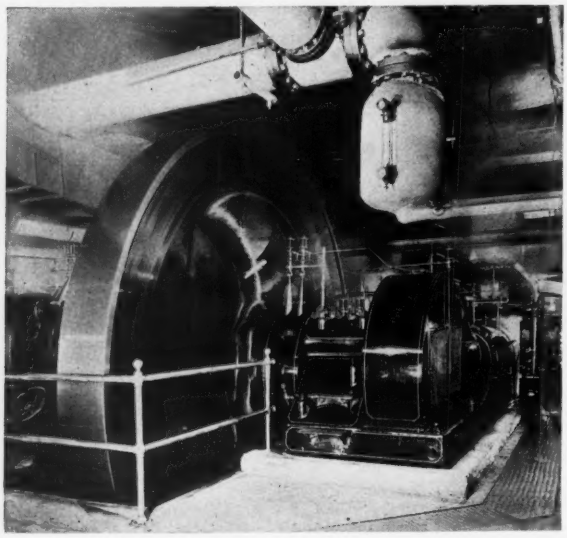


FIG. 7. RECENTLY-INSTALLED ALLIS-CHALMERS ELECTRIC GENERATING UNIT

for the entire waste. Each of the units, of which there are 2 placed in a pit below the level of the floor, consists of a cast-iron tank, or ejector, into which the sewage flows by gravity. As the sewage rises in the ejector, it raises a floating cast-iron bell which, through the medium of connecting rods and links, operates an automatic valve on the outside of the ejector, admitting compressed air at a pressure of from 30 to 35 lb. and forcing the sewage through a check valve and trap into the city sewers. This continues until the level of the sewage falls to such a point as to cause the weight of a second inverted bell suspended above the lower bell to throw the system out of equilibrium, reversing the automatic air valve and cutting off the supply of compressed air.

This air, which is compressed by one of two 7 by 10-in. double-acting air compressors belted to 15-hp. Crocker-Wheeler direct-current motors and furnished by the Worthington Pump and Machinery Corporation, is stored in a 5 by 10-ft. vertical tank. The motors driving the compressors are automatically controlled, being started when the air pressure in the tank falls to 24 lb. and stopped when the pressure reaches 35 lb. Electric controlling equipment was built and installed by C. J. Anderson & Co., Chicago.

Electric Current and Steam Requirements

Current for electric light and power and for charging the company's automobile batteries is generated at a voltage of 110 and is distributed through conductors carried in iron conduits. The present peak load is 7500 amp., or approximately 825 kw.

Electric motor power is employed for various purposes ranging from that of operating the drink mixers at the soda fountain and requiring but a small fraction of a horsepower each to the driving of a 40-ton carbonic compressor, which requires 350 hp.; the total number of motors in use is over 300.

In like manner, steam is used to meet a diversity of requirements, although the greater portion is employed for engine and pump operation and heating; the Webster system, carrying a pressure of 1 lb. or less is installed throughout and except in extremely cold weather and on Sundays is supplied with exhaust steam.

Other places where both live and exhaust steam are used are the culinary departments of the 3 restaurants, the candy kitchen, the soda fountain, the private laundry and the glue pots and dry kilns in the carpenter shop.

Refrigeration

Two complete and independently-operated refrigerating equipments are installed. The smaller one on the 15th floor, consisting of a 16-ton compressor made by the American Carbonic Compressor Co., and driven by a 35-hp. Crocker-Wheeler motor, is used exclusively in connection with the ice cream manufacturing department which has a capacity of 1200 gal. per day.

The ingredients used in making ice cream are mixed and churned in kettles chilled by brine circulating through an outer compartment, and after the mixture has reached its required consistency, it is packed into 1 quart tins. These are then placed in an ice box, having dimensions of 20 by 15 by 10 ft. high and maintained at a temperature of 0 deg. F., where the cream is allowed to harden and is kept in storage until called for.

All other refrigeration, such as the cooling of the ice boxes in the restaurant kitchens, the bakery, the meat market, the grocery department, display cases in the delicatessen store and the soda fountains is cared for by a 45-ton Kroeschell carbonic compressor located in the engine room and driven by a 350-hp. motor. Two boxes in the meat market are each 8 ft. wide, 10 ft. high and 30 ft. long; those in the grocery department, used for the cooling of butter, cheese and eggs are 4 in number, 4 ft. wide, 8 ft. high and have a combined length of 60 ft.; the 5 boxes in the restaurant and bakery kitchens are each 8 by 10 by 9 ft. high and like the others are maintained at a temperature of approximately 40 deg. F.

In some tests on burning Illinois screenings, the ignition arch at 11 in. above the chain grate stoker did not give satisfactory results. Raising it to 13 in. improved performance materially, but a further raise to 15 in. again was detrimental; which shows the need of attention to apparently small details if the best results are to be secured.

Some Notes on Belting

PROPER SIDE OF BELT TO USE; REQUIRED TENSION; SHORT BELT DRIVES. BY FRANK RICHARDS

LEATHER belting for transmitting power where rotating machinery is employed is a very old—it is not safe to call anything the oldest—mechanical device, and there seems to be no likelihood of its being discarded. In fact, the articles upon belting which are appearing in the current technical press give evidence of a live interest in the topic, which interest is doubtless to be attributed to the increasing and extending employment of belting, and this is easily accounted for by the numbers of electric motors which are coming into steady employment. This extension of electric service especially calls for good belting and for correct belting practice.

There are few if any mechanical devices which have so many variable conditions affecting their satisfactory employment, and yet it is a curious fact that, notwithstanding the long years of experience in the use of belting, scarcely one of these conditions is yet taken out of the debatable class. For instance, there are 2 sides to a belt, which sides it ought to be easy enough to designate. There is the hair side, the side on which the hair grew, and the flesh side; but even these 2 simple terms are not universally employed. Some talk about the "grain" side of the belt, and immediately I don't know what they are talking about, so that there will be no grain side to any of the belts that I may here present.

But, vastly more important than the naming of the belt sides, there is still much question as to which of the sides should be in contact with the pulleys and do the driving. Of course, with the surfaces of the 2 belt sides so different from each other, one must be better than the other for adhesive and driving effect; but there is still much discussion and no decisive agreement as to which it should be.

The hair side of the belt as it is manufactured and finished for use is smooth and hard. The pulley surface, if microscopically examined, has minute elevations and depressions; the hard, smooth, unyielding hair side of the belt can only touch the high spots of the pulley surface and may not have actual contact with more than ½ of it. The flesh side of the belt is more or less soft and yielding, so that when it is pressed against the pulley, either by the initial tension of the belt or by the actual pull of the drive, it will naturally more completely fill and interlock with the minute, the microscopic, interstices of the pulley surface. The use of the belt with the hair side out, the outside of it in the original roll, has also its better appearance to recommend it. I have used and applied thousands of belts and have never of my own volition used one with the hair side in contact with the pulley. I have, of course, seen belts enough used in that way, but have never discovered anything other than objectionable in the practice.

For driving efficiency much, of course, depends upon the actual condition of the surface of both the pulley and the belt. The pulley should not be polished, but preferably as a scraping or wide faced, coarse feed turning tool will leave it. The belt should be treated with a dressing which will soften, and keep permanently soft, the driving surface, at the same time have a beneficial effect upon the inner texture of the leather. I have known sticky dressings to be applied containing rosin which gave immediate and temporary adhesive effect, but which rapidly destroyed the belt by a species of dry rot. A dressing is valuable and effective not by reason of any stickiness but because of its softening and preservative effect. As a general rule, dressings are thought of only when the belt gets so dry and hard that it does more slipping than driving. Belts are dry and hard when they are new, so that dressing should be applied to them at the very beginning as is now done by some belt manufacturers.

It is really astonishing how long belts will last if properly prepared in the first place and if wisely treated afterward. I have known many belts which did not seem to wear at all and gave no signs of growing old. The best treatment in many cases is simply to keep them clean and otherwise to leave them alone as long as they are all right.

BELT TENSION

A BELT at work does it all by pulling, and the power transmitted by a belt is determined by the tension of the pulling or driving side minus the tension of the returning side. The practice usually followed in sewing or splicing a new belt in places has been to give it so much initial tension that there shall always be all the pulling tension on the driving side with some additional tension still in reserve on the returning side.

In the paper on belting by F. W. Taylor, which was the first paper he ever read before the American Society of Mechanical Engineers, he recommended the actual measuring and adjusting of the tension of the belt, by means of a spring balance or equivalent device, when it is laid in place on the pulleys and previous to its permanent lacing or splicing. In a book on belting published by a disciple of Mr. Taylor tables are given to show the "tensions under which a belt should be put to give the most satisfactory results." This is quoted from a prospectus of the book.

Now, Mr. Taylor in everything he wrote stated only his absolute and generally his intense belief. There never lived a writer more sincere in his convictions or more sure that they were precisely correct. He wrote only gospel truth—as it appeared to him. Nevertheless, with all due respect to the memory of one whom the engineering world has honored for the good work he did, this about belt tensions, in the light of common sense, and in the light of advanced modern practice, is absurd.

In the first place, the tension of the belt, however correctly it might be adjusted to begin with, would not remain constant. Not only would it at once begin to stretch, but its length would vary continually with the changing atmospheric conditions. Ignoring the perma-

nent elongation by stretching, the belt on account of the atmospheric humidity might sometimes have too little tension for the driving requirements and sometimes too much.

Why Belt Tension

Suppose a belt in its width and thickness to be only a little more than sufficient for the work that is required of it. Suppose it to have such a tension and such elasticity that it will be able to do its work when it is longest and "slackest;" then when the atmospheric conditions changed and it became shorter and tighter it would be too tight. It would be overstrained, and most likely beyond the limit of its elacticity, so that before long it would be necessary to have it spliced again. The experience of having belts alternately too tight and then too slack if some means of take up were not provided was a too familiar one in old times, but why have it now?

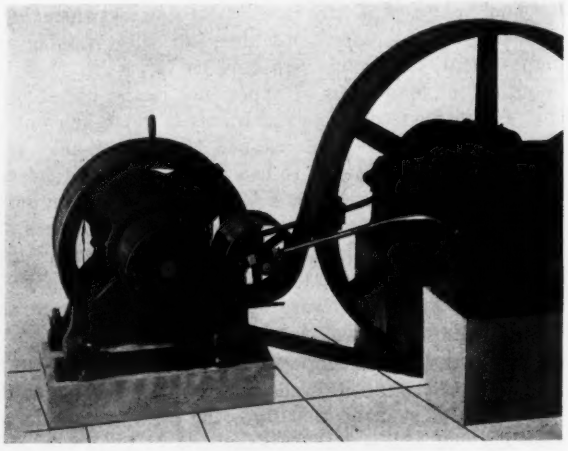
A belt too tight for the work it has to do is doubly costly. Such a belt must be heavier, stronger, must cost more, than necessary. Say that a certain belt would do all the work required of it with an effective running pull or tension of 1000 lb., and say that, on account of the tightness of the belt, there is a running tension of 500 lb. on the returning or "slack" side of the belt, which assumption is not extravagant as things go, then the actual pull on the driving side of the belt would be 1000 plus 500 or 1500 lb., this evidently calling for 50 per cent more strength of belt than would be otherwise necessary.

And here comes in the second unnecessary expense entailed by the tight belt. If the initial tension of the belt is to be depended upon to secure the proper working tension, this must remain in the total pull of the 2 sides of the belt even when running light and cause unnecessary friction in the bearings. At the best in the case assumed above, with a 1000-lb. pull on the driving side and little or nothing on the slack side, the pull on the bearings when doing no work would still be 1000 lb., being then 500 lb. on one side and 500 lb. on the other. In the case with 1500 lb. tension on the driving side and 500 on the slack side the total pull on the bearings of both the driving and the driven shafts would be 2000 lb. This accounts for the lost power which experiments show in driving belted line shafts even when no working power is being transmitted.

There should, in fact, be no tension on the slack side of the belt when working, and there should, theoretically at least, be no tight belts at any time. In addition to this, all belts should be automatically adjustable and compensatory for variations of length caused by changing atmospheric conditions. If a belt is used in a horizontal position, or even at any angle up to, say, 45 deg., with the pulling side of the belt at the bottom and without initial tension in the belt, the sag of the slack side of the belt caused by the weight of it will be sufficient, if proper and sufficient pulley and belt surfaces are provided to make the belt hug the pulleys and do its work without slipping. If the length of the belt varies on account of weather changes, the sag of the belt may be more or less; but until the upper belt actually bows down to touch the lower belt in running, it should do its work with perfect satisfaction, and only when this limit is reached will it be necessary to shorten and resplice the belt.

The Short Belt Drive

Better even than the horizontal belt drive, as here spoken of, is what is now known as the short belt drive. This is to be regarded with the greatest respect, because it is not in any way a makeshift for the saving of space but brings with itself important and substantial advantages. The illustration herewith shows a typical short-belt drive. The pulleys are quite close together and with the slack side of the belt so short, the weight of it might not be quite sufficient in all cases to give the required adhesion, but a light idler pulley is placed so that its weight rests upon the belt and it is so held in position by the rods which are journaled to the main pillow block that it is free to rise or fall as the varying slackness of the belt may demand. This not only secures the required tension by the weight of the idler pulley, but, as will be seen, the belt is carried so far down around the small pulley, in this case the driver, that more than 50 per cent is added to the area of contact of belt and pulley, which is a valuable item when the pulley is so small.



A TYPICAL SHORT-BELT DRIVE

With belt drives which are so unfortunately circumstanced that the slack of the belt is on the bottom instead of on the top, there is still no excuse for running with a tight belt. An idler can easily be provided in such a case under the belt and so counterbalanced that it will keep up a constant lift on the belt and eliminate the slackness. In the same way a vertical belt of any responsibility should be provided with a floating or self-adjusting idler pulley.

The arrangements here spoken of which automatically compensate for the ordinary changes in the length of a belt, after the first working stretch has been taken up, make it generally possible to run belts for a great length of time without resplicing. This should tend to diminish if not to abolish the use of belt laces. The lace holes in a belt must reduce the strength of the entire belt 25 per cent or more. The lace makes a bunch which at best cannot run over the pulleys quite smoothly at high speed and the lacing is not as lasting—or everlasting—as is a good belt. Good splicing makes a belt continuously homogeneous and "every part as strong as the rest."

Estimating Condensing Water

CHART FOR MAKING CONDENSER CALCULATIONS IS VALUABLE TIME SAVER. BY HAYLETT O'NEILL

THE rate of cooling water supplied to a condenser may be estimated by considering it as a heater and calculating the heat exchange from the exhaust steam to the cooling water. In the following computations the effect of radiation is neglected and it is assumed that all of the steam admitted to the engine is exhausted to the condenser.

Each pound of steam supplied to the engine contains H_1 heat units. Part of this heat is converted into work in the engine, and the balance is retained in the exhaust. This, less the heat in the condensate, q_2, is given up to warm the cooling water.

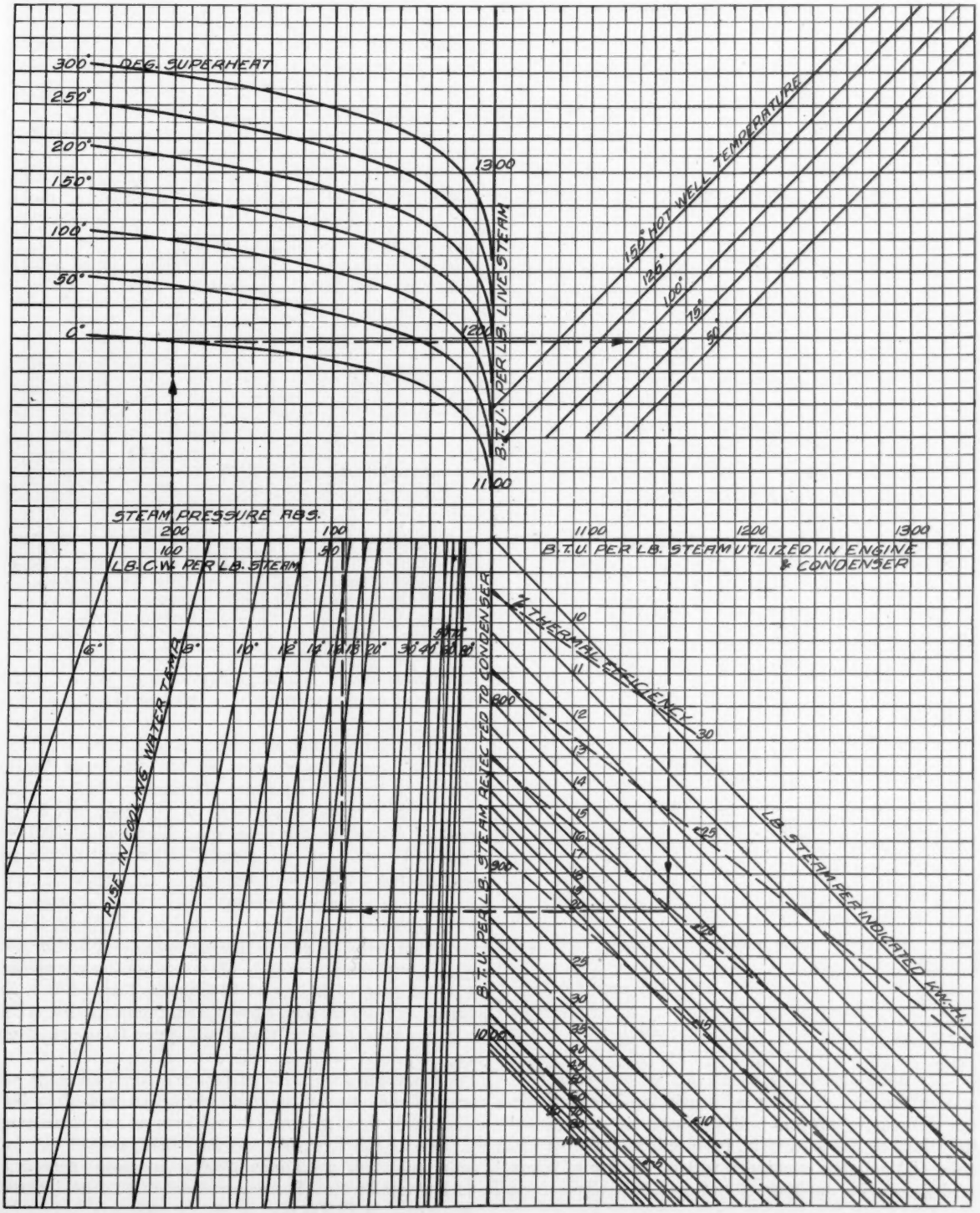


CHART FOR ESTIMATING THE AMOUNT OF COOLING WATER FOR CONDENSER AND THERMAL EFFICIENCY

W. R. = Lb. of steam per indicated kw.-hr.

Heat per lb. of steam converted into work in the engine $= \frac{3415}{W.R.}$, (3415 = B.t.u. in 1 kw.-hr.).

S. = Lb. of steam per hr.

C.W. = Lb. of cooling water per hr.

$T_2 - T_1$ = Rise in temperature of the cooling water.

Heat supplied for warming condensing water $= S\left[H_1 - q_2 - \frac{3415}{W.R.}\right]$.

Heat taken up by cooling water = C.W. $(T_2 - T_1)$.

$$S\left[H_1 - q_2 - \frac{3415}{W.R.}\right] = C.W.\ (T_2 - T_1)$$

$$\frac{C.W}{S} = \frac{H_1 - q_2 - (3415 \div W.R.)}{T_2 - T_1}$$

From the chart, the ratio of cooling water to steam can be estimated. Another method for determining rate of cooling water supply, often used, leads to results sometimes in considerable error; that is, to asssume that the steam exhausted to the condenser is dry and the temperature of the condensate is that of dry steam at the condenser pressure. Obviously, the steam at exhaust may be very wet, or even superheated, and the temperature of the condensate only approximates that of saturated steam at the condenser pressure.

To compare the two methods assume:

Dry steam at throttle:

W. R. = 15 lb. per indicated kw.-hr.

Steam pressure = 200 lb. abs.

Condenser pressure = 1 lb. abs.

Temperature of condensate = 80 deg.

$T_2 - T_1$ = 20 deg. F.

First method:

H_1 = 1198 B.t.u.

q_2 = 80 — 32 = 48 B.t.u.

$\frac{3415}{15} = 228$

$$\frac{C.W.}{Steam} = \frac{1198 - 48 - 228}{20} = 46.1$$

Second method:

H_2 = 1104

q_2 = 102 — 32 = 70

$$\frac{C.W.}{S} = \frac{1104 - 70}{20} = 51.6$$

$$\%\ \text{error of second method} = \frac{100\ (51.6 - 46.1)}{46.1} = 12.4$$

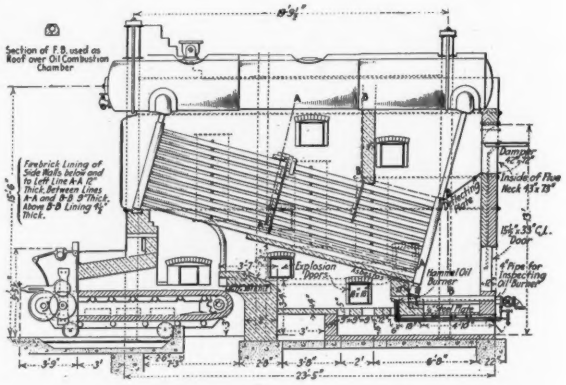
A SIMPLE APPROXIMATE rule for arc of contact of a belt on the smaller pulley of a pair is: Divide 5 times the difference between pulley diameters in inches by the distance on centers in feet; subtract the quotient from 180 and the remainder will be the arc of contact in degrees with an error of not over one degree for all probable cases.

Combination Oil and Coal Firing

IN the plant of the St. Joseph, Mo., Ry., Light, Heat and Power Co., oil burners of Billow and Hummel types have been installed in the rear wall setting of horizontal water-tube boilers to supplement the chain grate stokers in the front end and for emergency operation, as shown in the cut taken from Electrical World.

In some Stirling boilers grates have been removed and oil burners installed for regular operation; and in a Babcock & Wilcox the burners have been installed above Taylor stokers, the oil fuel being used for standard operation, but the stokers left available for emergency by a slight change which can be quickly made.

In the boilers with double equipment, the overload capacity was increased from 120 per cent of rating to 250 per cent so that peaks can be handled by using the coal for ordinary loads and turning on the oil burners for emergency without starting another battery, so that a minimum number of boilers may be kept in operation. Also the combination of systems makes it possible to cope readily with a scarcity of either coal or oil fuel.


Section of F.B. used as Roof over Oil Combustion Chamber
Fire brick Lining of Side Walls below and to Left Line A-A 12" Thick Between Lines A-A and B-B 9" Thick. Above B-B Lining 4½" Thick.
Explosion Doors
Hummel Oil Burner
4" Pipe for Inspecting Oil Burner
Inside of Flue Neck 43"x 73"
15'-3" C.L. Door

SECTION THROUGH BOILER SHOWING AUXILIARY OIL BURNERS AT REAR WALL AND PIPE FOR OBSERVING FLAME

With Kansas fuel oil having a heat value of 19,400 B. t. u., tests, as reported in the Electrical World, showed a furnace and boiler efficiency of 74.3 per cent at 87 per cent of rating and 76 per cent at 128 per cent of rating for the B. & W. boiler; and of 79.9 per cent at 80 per cent rating and 77.7 per cent at 108 per cent rating for the Stirlings.

AMERICAN GAS & ELECTRIC CO., of New York, is constructing a large power development at Windsor, W. Va., for the transmission of steam generated electric current over a distance of 55 miles to Canton, O. The station is more than half completed, the transmission line nearly completed, and the substation at Canton well under way.

While the generation of power at the coal fields and transmission to the point of utilization has often been discussed, development of such a project on as large a scale as this has not heretofore been worked out, and this will mark a distinct advance in power generation and transmission. The amount of power to be delivered to Canton is 62,500 hp.

Electrical Machinery and Appliances

For Generating, Transmitting and Using Current

Foreign Development in the Power Plant Field

RECENT IMPROVEMENTS IN INCANDESCENT LAMPS; GASES AND ARRANGEMENTS OF METAL FILAMENTS EMPLOYED WHICH HAVE RESULTED IN A DECREASE IN ENERGY CONSUMPTION PER CANDLEPOWER. BY J. H. BLAKEY

IN La Revue Electrique, M. Pausert describes some recent French and German patents relating to improvements in incandescent lamps. As is well known, the carbon filament has now been abandoned by inventors, as its only advantage, that of great solidity, is equalled if not surpassed by the tenacity of the metallic filaments as now made.

Arrangement of the filament has been the subject of many experiments. Thus, in the lamp of the German Lampen Aktien Gesellschaft the filament is arranged in helical form, Fig. 1. The French Thomson-Houston Co. had previously been granted a patent on this arrangement, the method of mounting the filament only being different. The advantage of this arrangement is that a considerable length of filament can be used in a relatively small space, and in addition the light is emitted only in the lower hemisphere.

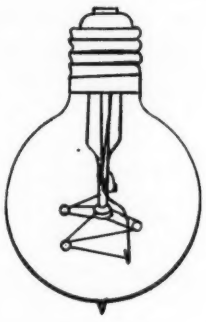


FIG. 1

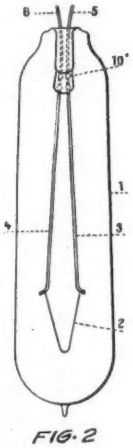


FIG. 2

FIG. 1. INCANDESCENT LAMP WITH FILAMENT ARRANGED IN HELICAL FORM

FIG. 2. INCANDESCENT LAMP WITH ELONGATED BULB CONTAINING FILAMENT OF DRAWN OR PRESSED TUNGSTEN

The Thomson-Houston Co. has made many experiments with the spiral arrangement, and has found that the close winding of the spires is not practicable unless a neutral gas is used, on account of the volatilization of the filament. The idea of using a neutral atmosphere was first suggested by Edison in 1883, the object being thus to raise the temperature of volatilization. But the idea was not put to use at the time, as the carbon filament, the only kind in use then, burning in an atmosphere of nitrogen, which is the neutral gas most suitable for the purpose, sets up a chemical action. This chemical action not only results in the deposit of a brown film of paracyanogen on the interior walls of the lamp, but also destroys the filament. This difficulty, however, does not occur with the metallic filament.

The Thomson-Houston Co. also makes a lamp with an elongated bulb, Fig. 2, French patent No. 466,581, March 6, 1914. In this the filament, of drawn or pressed tungsten is suspended in the lower part of the bulb by wires which pass through the base of the lamp. The nitrogen in the interior of the bulb has a pressure of 50 mm. of mercury (about 1/15 atmosphere) and is previously purified and rid of all moisture by passing many times over phosphoric anhydride, while the walls of the bulb are carefully dried by keeping it for a considerable time in a vacuum and heating in a furnace. This lamp, with a current of 8 amp., has a consumption of 0.7 to 0.8 w. per candlepower. Its life is about the same as that of the drawn tungsten lamps which are sold with a guaranty of an efficiency of 1 to 1.25 per c.p.

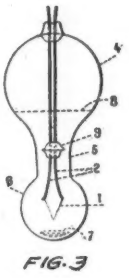


FIG. 3

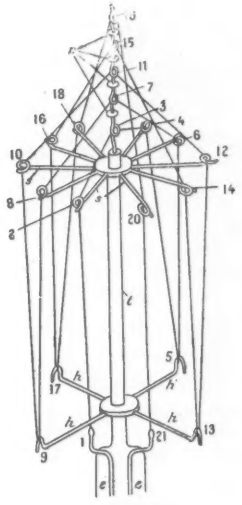


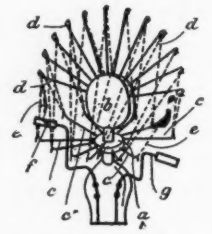
FIG. 4

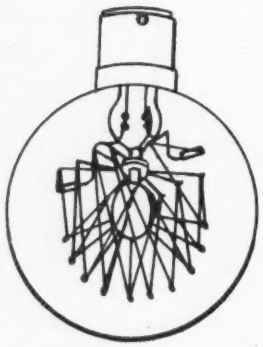
FIG. 3. INCANDESCENT LAMP WITH ATMOSPHERE OF A COMBINATION OF MERCURY VAPOR AND NITROGEN

FIG. 4. ARRANGEMENT OF FILAMENT PRODUCING LARGE AMOUNT OF LIGHT IN LOWER PART OF BULB

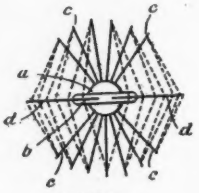
But notwithstanding the care taken to exclude all moisture from the bulb, it frequently happens that a sufficient amount remains to affect the life of the lamp. For this reason the same company has constructed a lamp in which the atmosphere is a combination of mercury vapor and nitrogen. The mercury has the property of protecting the filament against the action of moisture, and in addition its presence lowers the rapidity of vaporization of the tungsten more than any other inert gas. This lamp is shown in Fig. 3. The filament, of 0.25 to 0.5 mm. diameter, may be of the form shown or may be arranged as a close spiral. The upper part of the bulb is a condensation chamber connected by a neck to the lower part, in which the filament burns and which contains a small amount of mercury. When the current is turned on, the mercury is vaporized by the heat; the vapor thus formed drives the nitrogen into the condensation chamber, and with it any moisture which it may contain. At the moment of ignition the pressure of the mercury vapor is very small and the volatilization of the filament is prevented by the presence of the nitrogen, which diffuses only very slightly into the mercury vapor. When the lamp reaches its maximum temperature the mercury vapor rises to a point indicated by the dotted line 8. As the nitrogen has only 1/7 the density of the mercury vapor the latter drives the former into the upper part of the condensation chamber, and the amount of mercury is calculated to produce a pressure of about one atmosphere in the interior of the bulb when the maximum temperature is reached. Another advantage of the presence of the nitrogen is that when the current is first turned on, the pressure of the mercury vapor being then very small, there is danger of the current jumping across the electrodes. Consequently the pressure of the nitrogen alone must be sufficient to prevent this.

FIG·6





FIG·5



FIG·7

FIG. 5. METHOD OF SUPPORTING FILAMENT IN LAMP OF THE WESTINGHOUSE METAL FILAMENT LAMP CO.

FIG. 6. PERSPECTIVE VIEW OF FILAMENT, WESTINGHOUSE METAL FILAMENT LAMP CO.'S LAMP

FIG. 7. PLAN VIEW OF FILAMENT, WESTINGHOUSE METAL FILAMENT LAMP CO.'S LAMP

An arrangement of the filament by which a large amount of the light is produced in the lower part of the bulb, is shown in Fig. 4. This is the lamp of MM. Kruger and Sannig. The course of the filament can be traced by following the numbers from 1 to 21 in their order. This arrangement of filament allows a considerable length in a bulb of small size. At the points marked p in the drawing are insulation pieces of glass.

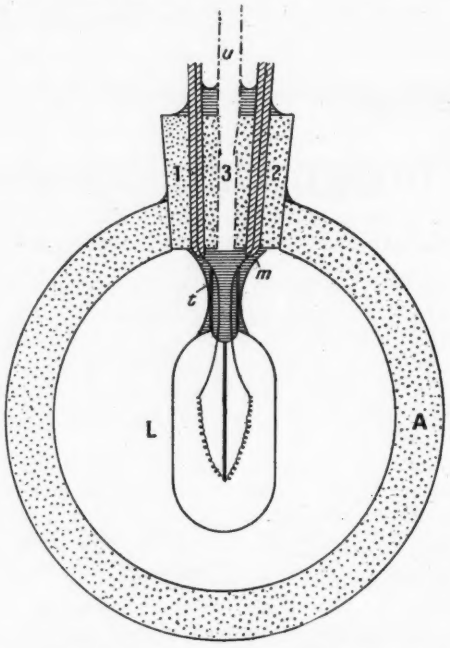


FIG. 8. EXPERIMENTAL LAMP EMPLOYED BY M. PECZALSKI TO DETERMINE LUMINOUS EFFICIENCY OF A TANTALUM LAMP

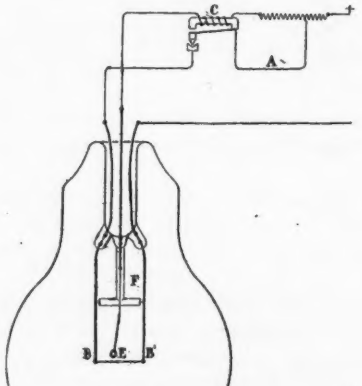


FIG. 9. PERFECTED EDISON AND SWAN UNITED ELECTRIC CO.'S INCANDESCENT LAMP

Figures 5, 6 and 7 are different views of the lamp of the Westinghouse Metal Filament Lamp Co. This disposition of the filament also gives great length in a spherical bulb of small diameter, and the shortness of each section is a safeguard against shock.

Figure 8 shows the experimental lamp used by M. Peczalski to determine the luminous efficiency of a tantalum lamp. The balloon of thick glass A has a plug 1, 2, ground and cemented into it. In the center of this plug is a tube 3, communicating with the interior of the balloon by a small space between the lower face of the plug and the upper face of the lamp holder. Consequently, if the balloon is filled with a liquid this can be made to rise in the tube and thus give a measurement of the amount of heat given off by the lamp. The balloon is now filled with a 2 per cent solution of copper chloride in water, and the lamp being illuminated, the height to which the liquid rises in the tube is noted. Then the lamp is withdrawn and covered with a coating of black varnish which is perfectly opaque but which allows the passage of heat. On illuminating the lamp the second time, the height of the liquid is again noted. By this means M. Peczalski concludes that with the particular lamp used, one British candlepower of light is produced by 0.06 w. of electrical energy. That is to say, if the ordinary half watt tungsten filament lamp has the same luminous efficiency, then about 7 times as much of the total energy goes to produce heat as is given off as light.

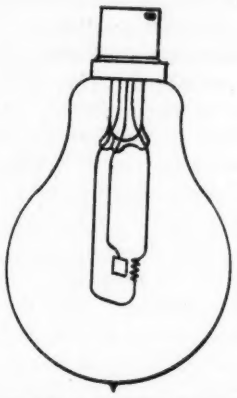


FIG. 10. EDISON AND SWAN UNITED ELECTRIC CO.'S 500- TO 1000-CANDLEPOWER INCANDESCENT LAMP

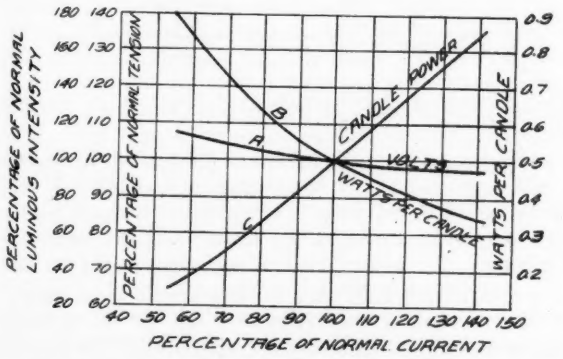


FIG. 11. CHARACTERISTIC CURVES OF EDISON AND SWAN UNITED ELECTRIC CO.'S INCANDESCENT LAMP

Figure 9 represents the perfected Edison and Swan United Electric Co.'s lamp, which was described in Practical Engineer of May 15. The drawing shows a direct-current 100-candlepower lamp. As will be seen by an examination of the figure, the current first reaches the pole B of the ionizer BB'. After a few moments, the electromagnetic interrupter C acts and diverts the current to the electrode E. F is the dilatation piece. Figure 10 shows the form of lamp used for higher powers—from 500 to 1000 candlepower—in which the dilatation piece is dispensed with and in which the positive electrode is of rectangular form. The intrinsic brilliancy of this lamp is so great that electrodes giving a light of 500 candlepower can be enclosed in a bulb of 10 cm.—about 4 in. diameter. This property can best be appreciated by comparison. The old carbon filament lamp, consuming 3.5 w. per candle, had an intrinsic brilliancy of 58 candles per square centimeter. The metallic filament 0.5 w. lamp is rated in the same way at 155 candles per square centimeter. This new lamp, when consuming 0.5 w. per candle, has an intrinsic brilliancy of about 1550 candles and a limit of 4650 candles at highest power. Figure 11 gives the characteristic curves of the lamp. Curve A shows variation of tension in relation to intensity; curve B gives the consumption in watts per candle with varying current; and curve C shows the variation of luminous intensity with the current consumed. An examination of the spectrum of the light given by this lamp leads to the belief that it will prove valuable not only for ordinary photography but also for photography in colors.

Direct-Current Generator Characteristics

INFLUENCE OF MACHINE SPEED ON COMPOUNDING AND COMMUTATION. BY GORDON FOX

CHANGES in rotational speed of a direct-current generator may affect 2 operating features. The compounding will always be influenced to some extent and commutation may be either bettered or impaired, depending upon the nature of the change.

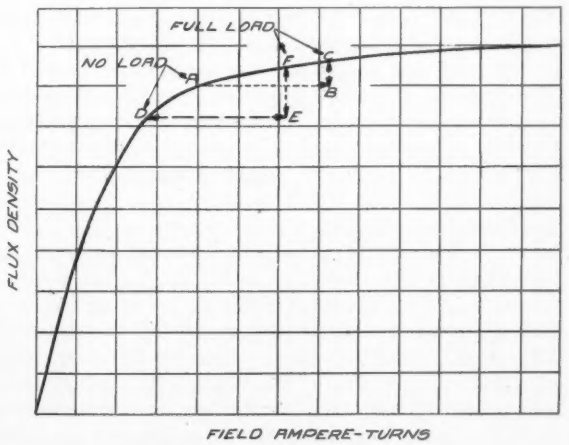


FIG. 1. MAGNETIZATION CURVE

We will first consider the relation between speed and compounding. In order to obtain stability of voltage the field coils of a generator are usually worked to a point a little above the knee of the magnetization curve. If the no-load normal-voltage point is below the knee of

the curve, a slight drop in speed causes a decrease in voltage. This, in turn, decreases the shunt excitation and tends to lower the voltage still further, so that stability is questionable. The terminal voltage of a generator depends on the density of the field flux and the rotative speed, since these factors decide the rate of cutting the magnetic flux. It is evident that when the speed is increased the magnetic density may be decreased and vice versa, the terminal volts being maintained at a constant value. It is thus seen that the location of the no-load normal-voltage point on the magnetization curve depends on the speed. The series-field influence at full load is electrically represented by a definite number of ampere-turns. The effect which these ampere-turns may have upon the voltage depends upon the degree of saturation. If the no-load normal-voltage point be low on the curve, the series turns will have greater effect than if the iron is pretty well saturated at no-load magnetization.

Figure 1 is the magnetization curve of a 230-v. direct-current generator operating at 250 r.p.m. Point A represents the magnetization corresponding to delivery of 230 v. without load at 250 r. p. m. The series ampere-turns are represented by the distance AB. The full-load voltage is higher than the no-load voltage by an increment BC, which represents the amount of overcompounding. Now let us assume that the generator speed is increased to 275 r. p. m. The no-load corresponding to 230 v. at the terminals would now be lower on the curve, about 10 per cent lower in fact, because the speed has been increased 10 per cent. This point is shown in Fig. 1 at D. The same number of series ampere-turns at full load exist as before, the distance DE (equal to AB) representing this magnetizing influence. The overcompounding is here shown by the increment EF. It will be noted that the distance EF is considerably greater than BC. This means that the generator will overcompound to a greater degree when operated at 275 r. p. m. than when driven at 250 r. p. m., other conditions being unchanged. The distance EF does not show the voltage rise accurately. It represents the increase in magnetic density from no load to full load. An equal increase in magnetic density will cause a greater increase in voltage at 275 r. p. m. than at 250 r. p. m., so that the rise at the increased speed is, in reality, greater even than is indicated by this curve.

The corrected regulation curves are shown in Fig. 2. The curve for the generator operating at 250 r. p. m. is here similar to portion A to C of the magnetization curve shown in Fig. 1. This curve is not strictly accurate, as engine regulation, armature reaction and internal resistance tend to cause the voltage to decrease with load. The increase in terminal voltage due to overcompounding causes the shunt-field influence to be greater under full-load conditions. This latter factor about offsets those first mentioned, leaving the curve as shown nearly unchanged. The curve showing the voltage regulation of the generator when driven at 275 r. p. m. is obtained from the portion DF of the curve in Fig. 1. The values are modified, however, by increasing the magnetic density increments, such as EF, by the ratio 275/250 to correct for increase in speed.

It is evident from these curves that a change in the speed of a direct-current generator will materially change the compounding. If a generator is operated much below rated speed it may be found that it has insufficient series effect to obtain the desired amount of overcompounding. If the generator is operated much above speed it will likely be necessary to shunt part of the load current around the series fields to lessen their influence. If a generator does not afford sufficient compounding, even when driven at rated speed, it may be possible to obtain the desired result by speeding up the prime mover. Operating below speed decreases the relative series-field influence, the ratio of series to shunt ampere-turns being low. Operating above speed increases the relative series-field influence, since the ratio of series to shunt ampere-turns is increased.

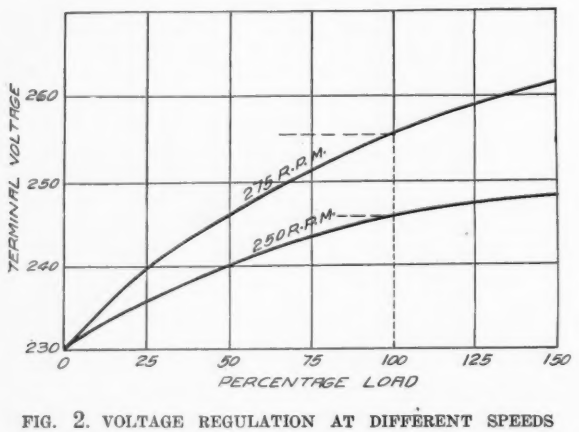


FIG. 2. VOLTAGE REGULATION AT DIFFERENT SPEEDS

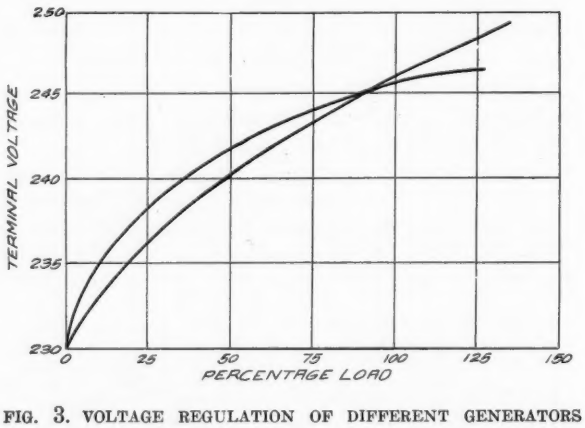


FIG. 3. VOLTAGE REGULATION OF DIFFERENT GENERATORS

The portion of the magnetization curve over which a generator operates has an influence upon the amount of curvature of the voltage-regulation curve, and this may materially affect parallel operation. In Fig. 3 are shown 2 voltage-regulation curves of 2 generators having equal voltage rise from no load to full load. They are both equally overcompounded. But, at fractional loads, for instance at half load, there is considerable voltage difference. If these 2 generators were connected in parallel, machine A would take a greater share of the load at this point. In order to secure correct load division over the entire operating range, 2 or more generators

must have compounding curves which are similar. As previously stated, the shape of the regulation curve depends largely on the portion of the magnetization curve upon which a machine operates. It was shown that speed changes cause a generator to operate over different portions of the curve. It is thus evident that by slight adjustments of prime-mover speed it is possible to modify the compounding curves in such a manner as to improve the load division by causing the machines to have similar voltage-regulation characteristics.

The second effect upon operation due to speed change is in respect to commutation. A generator, driven above rated speed, will deliver rated voltage at a lower degree of magnetization than the normal value. This means that the field ampere-turns are reduced and the field iron will be worked at a lower saturation than normal. Since the armature magnetizing effect remains unchanged, its relative value or ratio to field turns is increased. This involves a greater shifting of the neutral with load changes and is unfavorable to good commutation. The full-load neutral will probably occur at a point further removed from the no-load neutral than is the case for normal operation. Re-location of the brushes thus becomes desirable.

In an opposite manner, if a generator be operated below rated speed the ratio of armature to field turns is reduced, the neutral becomes more stable and commutation is improved. Consequently, if a generator operating at normal speed tends to spark and it is found that the neutral shifts widely with load so that a single brush position will not answer for all loads, conditions may be improved by slowing down the engine or, in case of a belted machine, changing pulleys. The allowable speed reduction is limited by the ability of the machine to deliver rated voltage without cutting out the field rheostat altogether and by the compounding which, as was previously explained, is reduced with decrease of speed.

It may be mentioned that speed changes will also have an effect on the temperature of a generator. When operating at increased speeds the iron is worked lightly so that core losses are low. The increase in windage and ventilation also tends to cooler operation. In opposite manner, when the machine is operated below speed, it will tend to run warmer. The shunt field coils in particular will be affected, since more shunt ampere-turns are required to secure the desired no-load voltage.—ELECTRICAL REVIEW AND WESTERN ELECTRICIAN.

Construction and Operating Data on Diesel Engines*

INFORMATION FOR MAKING ESTIMATES AND CURVES FOR RAPID CALCULATION

WHILE it is, of course, impossible, without a thorough examination of local conditions, to give an accurate estimate of the cost of electric current generated by Diesel engines, the curves in the Practical Reference Tables will undoubtedly facilitate calculations by those contemplating the installation of this type of prime mover.

In the first are shown representative construction costs of various sized plants. The figures include real estate, buildings, engines, generators, switchboards and accessories, oil storage tanks and piping. It is assumed that the installation will consist of 3 units each of ½ the rated plant capacity, thus giving a reserve unit at all times. The 4000-kw. plant is assumed to consist of 5 1000-kw. engines.

In case no spare unit is provided, the cost of construction will be 20 to 30 per cent lower. The fixed charges will be correspondingly reduced, while the fuel consumption and repairs will be somewhat higher than if a spare unit is provided.

Other curves show operating and fixed charges per kilowatt-hour for plants operating at various average yearly load-factors, 24-hr. operation being assumed, as this is the condition which exists in most central station plants.

The curves of fuel consumption are based upon a careful study of both actual results of many plants and the guarantees of manufacturers. In central station plants consisting of more than one unit, the fuel consumption for any given load-factor would be less than the fuel consumption of a single unit operating at the same load-factor, because the ease of starting and stopping Diesel engine-driven generators, and the fact that the fuel consumption stops when the engine is shut down would enable light loads to be carried on a single unit operating at a relatively high load-factor.

As the price of fuel oil varies greatly in different parts of the country, and fluctuates considerably in the same location, we have arranged the plate so as to show the cost of fuel for various prices of oil—from 1 to 6 cents per gallon. For instance, a 1000-kw. plant (consisting of 3 500-kw. units) operating at an average yearly load-factor of 40 per cent would consume 0.10 gal. of fuel oil per kilowatt-hour at a cost of 0.30 cent per kilowatt-hour when paying 3 cents per gallon for oil. These figures can be safely taken as representative of what may be expected in any part of the country. They are affected less by local conditions than any of the other factors going to make up the total cost of electric current.

Labor costs per kilowatt-hour are based upon the following estimated total costs per year:

100	kw.	$1,800
200	"	2,400
500	"	3,600
1000	"	5,000
2000	"	6,500
4000	"	12,000

While these figures may be taken as representing average conditions throughout the country, still they may or may not be applicable to any particular situation, and should accordingly be altered in accordance with the local wage rate.

The labor per kilowatt-hour in all cases decreases rapidly with the increase in load-factor, because up to a certain period practically the same attendance is re-

*Taken from the Report of the Committee on Prime Movers, 1916 Convention, N. E. L. A.

quired regardless of the output of the plant. When this curve was submitted to certain manufacturers for criticism, they pointed out the fact that in a 100 or 200-kw. plant it would frequently be possible for the engine attendants to devote a portion of their time to other duties. Where this is possible a reduction in the amount chargeable to the operation of the engine may be made.

Charge for miscellaneous supplies includes the cost of such items as lubricating oil, waste and other minor supplies.

The fixed charges consist of interest at 6 per cent, taxes at 1 per cent, and depreciation at 5 per cent.

The cost of repairs depends upon the load factor of the station, which determines both the hours of operation of the units, and their kilowatt-hour output. Obviously, an engine will ordinarily require more repairs when operating at a high load-factor than when operating at a low one. We estimate that repairs will amount to 1 per cent of the construction cost at 20 per cent load-factor, increasing to 3 per cent at full-load. The percentages assumed for repairs were estimated after obtaining figures from a large number of operators and manufacturers. When submitted to the manufacturers they were criticised as being too high; when submitted to the operators they were criticised by several as being too low. This difference of opinion will be understood when it is remembered that the engines now in operation include many whose design is such that the cost of repairs is higher than manufacturers estimate for their later, improved types of engines; also, that the quality of material used in the construction of the older engines was not so good as at present, resulting in high repairs because of worn-out parts.

In view of these figures, based upon the past experience of operators, and upon the views of the manufacturers, founded upon what they expect from the improved designs they are now turning out, the figures given in this plate may be taken as conservatively representing conditions which need not be exceeded with careful operation.

It will be understood that the fixed charges applied in determining the over-all costs of the Diesel engine plants are the practical minima. Interest has been taken at 6 per cent which is the limit of return permitted in some states under drastic regulation. Obviously an 8 per cent interest and profit is a more logical base, and even 10 per cent or more should be considered in states where the cost of money and the investment risk are high. Furthermore, insurance expense is omitted as it may be and is sometimes neglected or disregarded. This item may vary from ¼ to ¾ per cent or more where the investment is properly protected, depending of course upon the character of the installation and the hazards involved.

If these additional costs of money and of insurance are included the cost of Diesel engine power would be consequently and consistently higher than indicated in the accompanying diagrams and curves.

DON'T DRIVE a hacksaw too fast. Sixty strokes a minute will cut faster, and the blade will last longer than at the customary race-horse speed.—The Gas Engine.

Rapid Estimation of Pumping Engine Sizes

MANUFACTURERS usually devise some means to estimate quickly the approximate size of their apparatus to suit the needs of a customer. In the Practical Reference Tables of this issue are published 2 charts compiled by the engineering department of the Allis Chalmers Mfg. Co., and printed recently in the Electrical World, for determining the size of pumping engines that will meet particular requirements.

To illustrate the use of the charts the following conditions are assumed: Capacity, 10,000,000 gal. a day; total head in feet, 200; piston speed, 250 ft. per minute; steam pressure, 140 lb. Starting in the upper left-hand square with the capacity (10,000,000), follow this line vertically until it intersects the head in feet (200), then continue horizontally to the diagonal line marked with the piston speed (250), from which drop to the steam pressure line marked (140). Horizontally opposite is the low-pressure cylinder diameter (50 in.). Where the horizontal line intersects the diagonal (140) is the high-pressure cylinder diameter (24 in.).

With the information secured in this way the stroke and floor space can be obtained from Chart No. 2. For example, starting in the upper left-hand square with the low-pressure cylinder diameter (50), trace vertically to the line marked with the high-pressure cylinder. Horizontally opposite this point is the width of the pump in feet (16 ft. 3 in.). Continuing to the steam pressure diagonal (140), and then dropping to the horizontal scale, will give the stroke in inches (36 or 42).

The length of floor space required is obtained by starting with the low-pressure diameter (50) on the lower left-hand chart, following the vertical line to the stroke (36), thence tracing the horizontal line to the diagonal marked with the capacity (10,000,000), and dropping vertically, where the length (36 ft.) is given. The piston-speed of 250 ft. per minute, and stroke (36 or 42) determines the revolutions per minute.

It might be pointed out in this connection that the duty of a plunger pump will remain approximately the same under change in head or capacity, dropping only 8 per cent of normal with ½ normal speed, 2 per cent with ¾ speed, and 2.5 per cent with 1¼ normal speed. With ½ normal head the duty drops only 9 per cent of normal, at ¾ head less than 1 per cent, and at 1¼ normal head about 7 per cent.

U. S. CIVIL SERVICE COMMISSION announces an examination for observer and meteorologist, on Nov. 22, to fill vacancies at salaries ranging from $1260 to $1800, in the Weather Bureau, Department of Agriculture, for duty in Washington, D. C., or in the field, and vacancies as they may occur. Applicants must show that they have had at least 3 yr. training in a college of recognized standing and that such training included work in physics, mathematics, plant physiology, or hydraulic engineering. Apply for Form 1312.

Size of Engine Bearings

IN the design of bearings it is customary to proportion them so that the pressure per square inch of projected area does not exceed a value which has been determined by practice to be satisfactory. On main bearings of engines this pressure ranges from 140 to 200 lb., on crankpins from 500 to 1000 lb., on crosshead pins from 1000 to 1600 lb., and on crosshead bearing surfaces from 30 to 50 lb.

Using these figures as the limiting values the accompanying chart has been devised by means of which the sizes of the principal bearings of an engine can be determined. To use the chart, simply trace from the point on the scale at the left representing the total load on the piston in pounds horizontally to the right until you meet the diagonal representing the allowable pressure on the bearing, then vertically down to the lower scale representing projected area of the bearing.

For the crosshead bearing surface, however, the ratio of connecting rod length to crank length enters the problem. To determine this bearing surface, start at the left hand scale of total load on piston, trace horizontally to the right until you meet the diagonal line representing ratio of connecting rod length to crank and designated as "cranks," then trace vertically up to the scale of total load on crosshead guide and continue to the diagonal representing the allowable pressure on crosshead bearing surface then horizontally to the scale indicated where the projected area of the crosshead bearing surface is found.

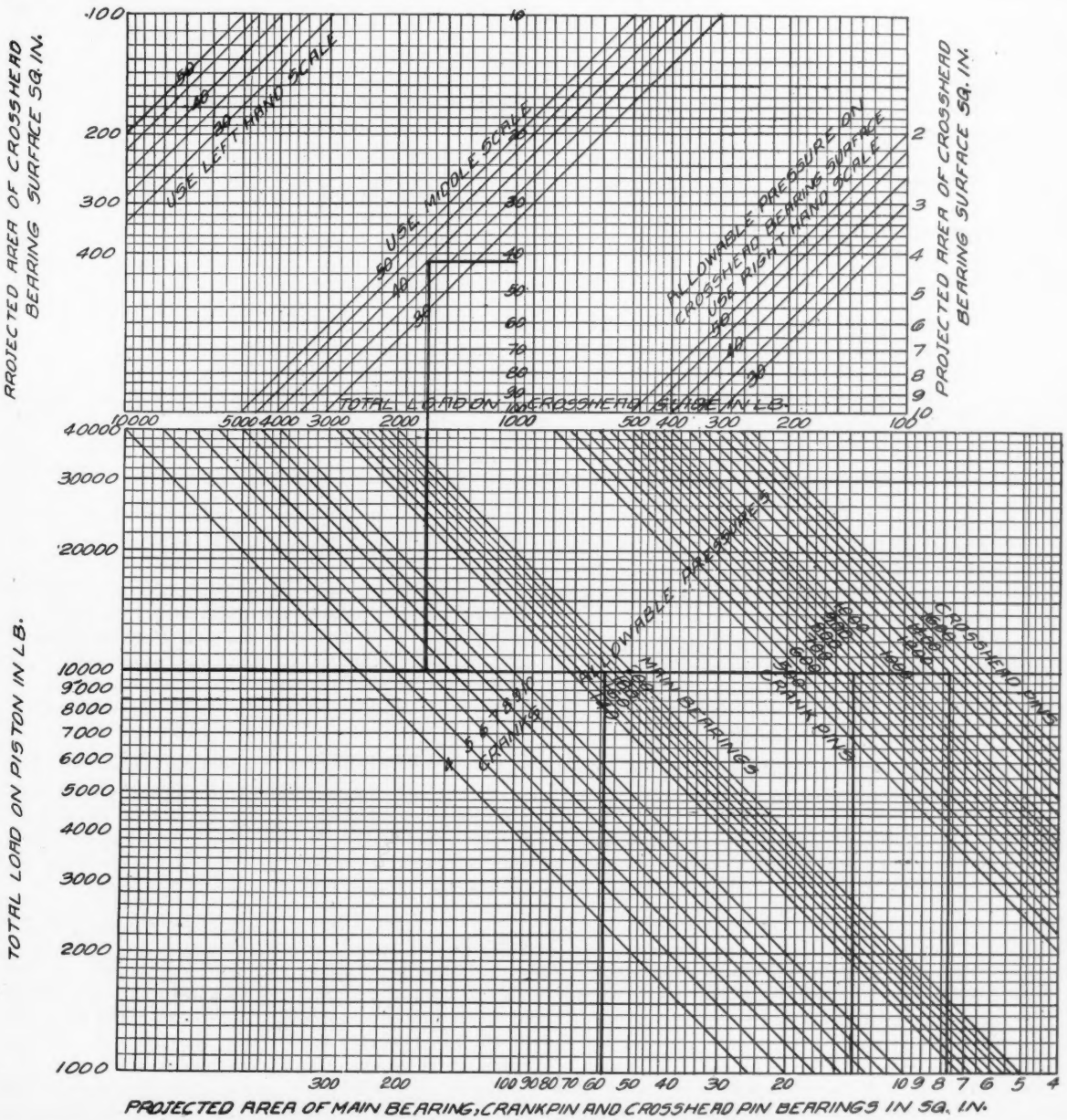

PROJECTED AREA OF CROSSHEAD BEARING SURFACE SQ. IN.
USE LEFT HAND SCALE
USE MIDDLE SCALE
ALLOWABLE PRESSURE ON CROSSHEAD BEARING SURFACE
USE RIGHT HAND SCALE
TOTAL LOAD ON CROSSHEAD GUIDE IN LB.
TOTAL LOAD ON PISTON IN LB.
ALLOWABLE PRESSURES
MAIN BEARINGS
CRANKPINS
CROSSHEAD PINS
PROJECTED AREA OF MAIN BEARING, CRANKPIN AND CROSSHEAD PIN BEARINGS IN SQ. IN.

CHART FOR DETERMINING SIZES OF ENGINE BEARINGS

LETTERS DIRECT FROM THE PLANT

Cash Paid For Ideas Accepted. Sketches Desirable.
We Make The Drawings

Maximum Belt Power

If it were not for centrifugal force, any belt could be made to transmit any amount of power by simply increasing the speed of the belt to the necessary point. The formula for such a condition would be:

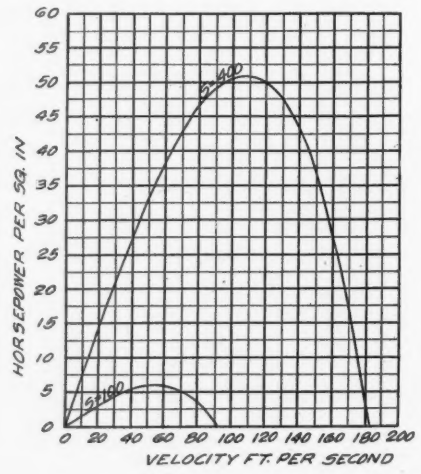
$$\text{Hp.} = \frac{SV}{550} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

Where S = strength of belt in pounds per square inch;
V = velocity of belt in feet per second.

But on account of centrifugal tension there is a speed at which any belt will "explode," even though it carries no load. Centrifugal tension is computed from the formula:

$$\text{Tension, lb. per sq. in.} = 0.012\ V^2$$

Therefore, in any belt, no matter what the speed, and assuming the initial tension to be zero, as it practically



VARIATION OF BELT HORSEPOWER WITH VELOCITY AND TENSILE STRENGTH OF BELT

is in slack drives, Lenix drives, or elsewhere where care has been used to give the belt plenty of surface contact rather than tightness, we must subtract the centrifugal tension from the strength of the belt. The useful tension then becomes—

$$S - 0.012\ V^2$$

Substituting this value for S in equation (1), we get:

$$\text{Hp.} = \frac{(S - 0.012\ V^2)\,V}{550} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

Assuming values of S = 100 and S = 400, I have plotted the 2 curves herewith, where it will be noted that the belt of 4 times the strength of the other will transmit more than 4 times as much power as the other. The velocity of the strong belt, of course, can be much higher, as the formulas above show.

Formula (2), however, is rather cumbersome. In order to find the maximum power that a belt will transmit by using that formula, we must make substitutions and plot a curve just as I have done, or, we must "cut and try" and tabulate our results. The maximum power is obtained by observing the peak of the curve. Thus, where S = 400, Hp. = over 50; and where S = 100, Hp. = over 6.

Applying differential calculus to formula (2), the problem is considerably simplified, however. I get this formula for the best belt velocity:

$$V = 5.27\sqrt{S} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3)$$

This makes it possible to find the maximum horsepower without "cutting and trying."

For example, what is the maximum horsepower for a leather belt using S = 400?

Applying formula (3):

$$V = 5.27\sqrt{400} = 5.27 \times 20 = 105.4 \text{ ft. per sec.}$$

Now, substituting this value for V in formula (2),

$$\text{Hp.} = \frac{(400 - 0.012 \times 105.4 \times 105.4)\ 105.4}{550} = 512$$

Four hundred pounds per square inch is seldom used for leather belts; it is a high figure. Taylor recommends about 240.

These formulas shows the value of high strength, though, and the possibilities that lie before us in the belting field. Belts are better made nowadays than years ago; they are stronger. Pulleys are also better. So, between the two, we should be able safely to "speed 'em up."

N. G. Near.

Care and Use of Leather Belts

In the Oct. 1 issue, page 840, the slip of leather belts running with the flesh side against the pulley is compared to the concave bottom glass. This experiment is true, and good, in a way, but does not cover fully the reasons for running hair side against the pulley.

From my experience with leather belts, I would say this:

In common practice, the hair side should be run next to the pulley. This side is harder and more liable to crack than the flesh side, being harder and smoother it will run smooth with less slip than the flesh side. By running the grain or hair side next to the pulley, the tendency is to cramp or compress it as it passes over the pulley, while if it ran on the outside, the tendency would be for it to stretch and crack.

The flesh side is the tougher side; but, for reasons given above, the life of the belt will be longer if the wear comes upon the grain side.

The lower side of the belt should be the driving side, the slack side running from the top of the driving pulley. The sag of the belt will then cause it to cover more of the circumference of the pulley increasing the pull, thereby giving more power.

Long belts running in any other direction than vertical, work better than short ones, as their weight holds them more firmly to their work.

It is bad practice to use rosin to prevent slipping. It gums the belt, causes it to crack, and prevents slipping for a short time only. If a belt is in good condition and persists in slipping a wider belt should be used. Sometimes larger pulleys on the driving and driven shafts are of advantage, as they increase the belt speed and reduce the stress on the belt.

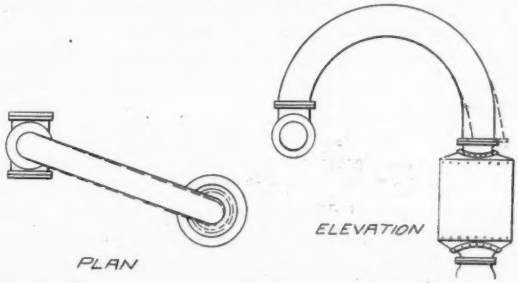
Belts may be kept soft and pliable by oiling them once a month with castor oil or neatsfoot oil.

W. B. N.

Trouble With Leaky Receivers

WE RECENTLY INSTALLED, in connection with a new engine unit, a sheet metal receiver which was connected to an extension of our main header by means of a full bend of 8-in. pipe, the inlet and outlet nozzles on the receiver being 8 in., and the shell being 30 in. in diameter by 50 in. over calking edges.

After all the piping, including the receiver, had been subjected to a test pressure of 250 lb., we put the unit in operation. In about 2 weeks, small leaks started to develop first around the calking edge at the bottom of the receiver and then around the top. These were calked



ELEVATION AND PLAN OF RECEIVER CONNECTION

tight several times by the boiler maker who made the receiver, but it never remained tight for over a week.

We finally talked the boiler man into the conviction that the single riveted seams at the top and bottom were not heavy enough, and that they should have been double riveted, and arrangements were made to have the receiver removed from the line and rebuilt, in the meantime inserting a filler-in piece.

The boiler man was on the job when we were ready to take the separator out of the line, and after we had removed the bolts in the upper joint he immediately noticed that the pipe sprung out from the separator about 2 in., as indicated on sketch showing elevation.

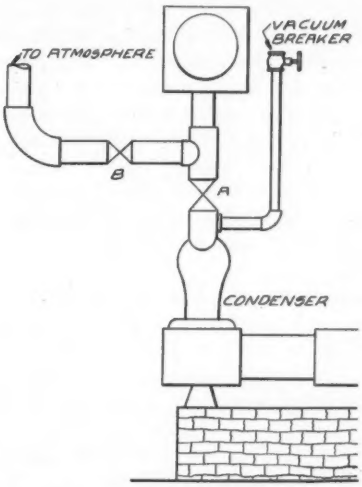
This, of course, accounted for the strain that was placed on the receiver and which was doubtless causing the leakage, and it was decided to give the receiver another try after it had been completely recalked. While this was being done, we also discovered that another lateral strain was being imposed, due to the expansion of the main header piping because this was anchored where the straight run to the bend was taken off.

After removing these 2 strains by readjusting the branch header pipe, we installed the same receiver, and it has showed no signs of leakage after being in service for 2 months, clearly indicating that the pipe strain was responsible for the original trouble. M. A. SALLER.

Operation of Condensing Engines

IN REPLY to the question asked by D. W. on page 893 of the Oct. 15 issue, on the starting of condensing engines, and answered by O. H. H., the writer desires to add the following:

When the engine is started as outlined by O. H. H., it exhausts into the condenser from the start and is termed "starting condensing." The accompanying illustration shows how the piping is often arranged, valve A being that referred to by O. H. H., and B being installed



ARRANGEMENT OF EXHAUST CONNECTIONS AS FREQUENTLY EMPLOYED

to enable repairs to be made on that line while running. In many cases, the valves A and B are not provided, which means that should anything occur to interfere with the condensing system, it would be necessary to stop the engine to make repairs.

Many men prefer to start an engine noncondensing. This means that, after the piping has been drained of condensation, the cylinders thoroughly heated and the condenser in operation with valve A closed and valve B open, the engine is started, exhausting through the atmospheric relief valve. When the engine is up to speed, valve A is opened and the engine runs condensing.

Many stop an engine by closing valve A, causing the engine to run noncondensing; then the condenser pumps and lastly shut the throttle valve. Even when valve A is provided, some men never use it unless trouble develops with the condenser, they start the condenser first and then open the throttle. In stopping, they close the throttle, open the vacuum breaker, and shut off the pump and circulating water.

Starting noncondensing possesses certain advantages under some conditions, as the writer has found in 2 plants under his charge. These have batteries of good size boilers, and as the fires are cleaned at night and no steam demanded, the fires are green in the morning. By starting the engines noncondensing about 10 min. before the load comes on a big pull comes on to the boilers, with the result that the fires have a chance to get burning in good shape. By the time the motors are all started, the engines running condensing, the dampers do not close and the draft acting on the fires keeps the steam rising to the pressure carried without checking the fires. As a result, we sustain no loss of pressure when the load comes on. RECEIVER.

Wooden Cog Gears

PERHAPS my experience in designing, supervising the construction and use of wood cog gears may be useful to the enquirer, R. S., page 893, Oct. 15 issue.

These cogs are commonly made of hard maple, but hickory or hornblende is better.

Experienced millwrights often boil these cogs after they are cut from well seasoned timber, and again seasoned in paraffin wax, beeswax or a mixture of these; others heat the dry wooden cogs in a cook stove oven and paint them with melted paraffin or beeswax with a brush, while some manufacturers only paint them cold with paraffin or wax dissolved in benzine; a cheaper method is to dip them cold in linseed oil, and the cheapest is to spray them with paint. I consider that they should always be at least dipped dry and hot in melted paraffin wax.

The teeth of the cast-iron pinion should always be machine cut, and very smooth—no tool marks—and the thickness of those teeth at the pitch line is commonly 40/100 to 35/100 of the circular pitch, while the thickness of the wooden cogs at the pitch line is about 57/100 to 62/100 of the circular pitch.

All gears should be on very stiff shafts well supported by bearings near the gears.

If the gears are to operate in a dusty place, always cover them with a duct-tight cover or hood.

Old experienced millwrights watch cog wheel drives very carefully, and frequently dose them lightly with "dope" which generally contains paraffin wax, very finely powdered talc and often flake plumbago, which is often made into sticks, perhaps 1½ or 2 in. diameter and a foot long, and held against the wheel while running, like belt dressing on a belt. No doubt such dressing moderately applied (so as to lubricate the rubbing surfaces and not clog the tooth clearances) lessens friction and wear. F. W. SALMON.

IN LOOKING over the Oct. 15 issue, I noticed an inquiry relating to preventing wear of wooden gear teeth.

I would suggest soaking the wooden teeth in boiling linseed oil for about an hour; if the wood is kiln dried, it will fill in that time, and after putting the teeth in the core gear paint them with a mixture of graphite and boiled linseed oil once or twice a week.

Use no other oil or grease of any kind. No further trouble with wear on the teeth will be experienced and the gear will run very smoothly.

I have used this mixture for years on core gears for lead mills and other power drives, and recommend it to prevent wear and prolong the life of wooden teeth in core gears.

The linseed oil hardens the wood and the graphite makes a glossy and smooth film over the wearing surfaces of the teeth. F. P. H.

Fixing Important Data in Mind

IN TRYING to make the important points of various articles which I read in Practical Engineer and other technical papers my own, I have found the use of a note book of help in order to sift out points which it is desired to carry in mind.

As an example: An article of several thousand words on the Dry Battery was read twice, and trying to think of some of the practical points to give to another fellow, I could not recall these, but tried the following: I re-read it with a note book at hand and made notes as follows:

Dry batteries will absorb moisture; always keep in a dry place. If the paper becomes wet and they lie with the sides touching, there is a chance of short circuit and leakage. In purchasing, reject any with damp paper outside.

In handling by the barrel, always truck—do not roll—to avoid breaking.

In storage, stand batteries on end—always use the oldest lot first; the cell, even when idle, will run down with age.

To make the best test of condition, connect the 2 binding posts with 3 ft. of No. 18 B. & S. copper, leaving them short-circuited for 5 sec.; then disconnect and immediately read the voltage with a voltmeter. For a good cell it should be at least 1.25 volts. The test of dry cells on an open circuit is worthless.

Low temperature decreases, while high temperature increases the amperage of cell. A room of moderate temperature is best.

In connecting up cells in series or parallel, use No. 18 B. & S. insulated copper wire, and be sure, when assembling the cells into a battery, that the zinc binding post at one cell does not touch the metal of the next cell, as this produces a short circuit. When putting up batteries, be sure that they do not stand on a damp board, as this will moisten the paper covering and cause a partial short circuit.

The writing down of these notes fixes the points in mind, and they can also be studied carefully in this brief form to make sure that they are remembered. I have used this method for some time and find it of great assistance. J. B. DILLON.

Method of Making Wire Solder

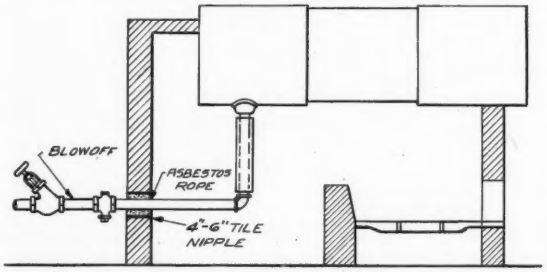
ON PAGE 879, Oct. 15 issue, under caption of "Some Electrical Repair Kinks," the writer tells us how to make wire solder. His method is all right but a quicker one would be to take a piece of tongue and grooved flooring, any convenient length, screw up in a vise or hold it on the floor, plug both ends with a small chip and hit one end against the floor; out comes the wire solder. If you want to flux it, put some powdered rosin in the groove every time before you pour the hot metal. FRED V. BROADAWAY.

Successful Kinks From The Plant

For Saving Time, Work and Trouble

Relieving Strain on Blowoff Pipe; Wrench Board Kink

I HAVE HAD considerable trouble with my blowoff pipe leaking, caused by too rigid a support in the boiler setting at the rear end or the setting sinking; in any case, here is a cure for it. When the furnace is repaired, cut a nipple from 4 or 6-in. sewer tile pipe, put it in the back wall where the pipes comes through, then put blowoff pipe in this and pack with asbestos rope.



METHOD OF BRINGING BLOWOFF PIPE THROUGH BACK WALL

When making your wrench board for engine room, paint it white, then hold up the wrenches and make a pencil-mark around each wrench or article that you want to put on it. When all tools are outlined, paint the reproduction on the board with black paint. When dry, put nails in the board to hold each tool over its painted image then you can tell at a glance just what is missing, for when the article is taken down there is the exact picture of it on the board. FRED V. BROADAWAY

Noiseless Water Heater

WHENEVER water is heated by the injection of steam, there is always that characteristic cracking sound unless some form of nozzle is used. Such a nozzle can easily be made from a few simple pipe fittings. The procedure is as follows:

1. Having heated the steam pipe up to a good welding heat, it may be drawn down to a point as shown in Fig. 1.

2. By means of a hack saw, saw off the end until the internal diameter of the nozzle is about ⅓ the internal diameter of the original pipe.

3. Cut a long thread on the nozzle-end of pipe.

4. Procure a reducing coupling of the size given in the list and drill holes as shown in Fig. 2, which is an assembly of complete nozzle.

5. Screw nozzle into coupling until the point of the nozzle projects about ¾ in. beyond the holes. Put a piece of pipe about 10 in. long in the other end of coupling for the passage of the condensed steam and water.

The high velocity of the steam jet sucks water in through the drilled holes in the coupling, and the steam and water coming together in this manner eliminates all noise which is present when a steam jet strikes water which is not in motion.

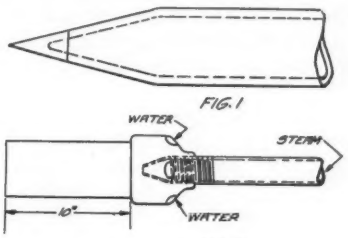


FIG. 1. STEAM PIPE DRAWN TO A POINT
FIG. 2. COMPLETED NOISELESS HEATER

The following suggestions are made as to sizes of inlet and outlet pipes:

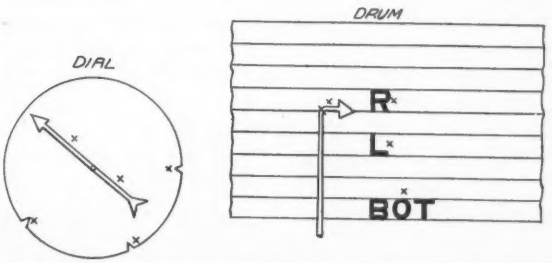
Steam Pipe	Outlet Pipe	No. and Size of Holes
¼	¾	4—¼ in.
⅜	1	5—¼ in.
½	1¼	4—⅜ in.
¾	1½	5—⅜ in.
1	2	4—½ in.

The sizes given are standard and ought to be easily obtained. Bushing can, of course, be used to reduce to the proper size, if the above sizes cannot be procured.

W. M. AFRICA.

Dial for Night Work

OPERATING first motion hoisting engines at a 300-ft. shaft coal mine at night, lowering and raising men, with the lighting system after midnight consisting of a torch



CONVENIENT FORMS OF DIALS FOR USE IN POORLY LIGHTED PLACES

filled with engine oil, is very dangerous. To overcome partially the rather obscure marks on the drum and indicator dial, the writer devised the following plan:

The indicator dial is painted black; the arrow or pointer, together with the landing marks, are covered with tinfoil.

On the drum the letters R, L and BOT are cut out of tinfoil and securely fastened to the drum (wooden) with large headed tacks.

Referring to sketch: All parts marked X are those covered or made of the tinfoil.

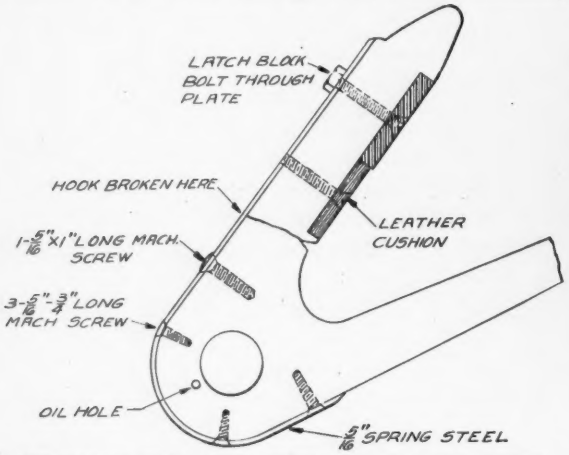
It is surprising how plain these marks show up and materially help a man working under these conditions.

JACK L. BALL.

Repairing a Broken Valve Hook

INVESTIGATING the cause of my Corliss engine failing to take steam on the head end, I discovered a broken valve hook. I had no spare hook on hand, and as the engine in question is used for the operation of a refrigerating machine, it was necessary that I devise some means to prevent a complete tieup of the plant.

Removing the broken member, I took it to a nearby blacksmith shop and by means of a short length of steel band such as used for carriage tires, and the necessary



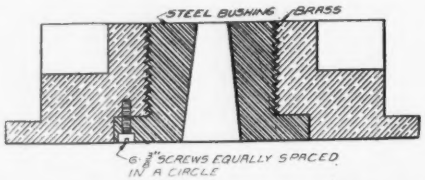
METHOD OF REPAIRING BROKEN CORLISS VALVE HOOK

bolts and machine screws, I repaired the hook as shown in the accompanying illustration.

It is now over 2 months since the break occurred and the hook is still in daily operation. Since then, however, I ordered a new one from the engine builders; this required over 4 weeks to arrive. CHAS. E. YEAKLE

Loose Steam Piston, Cause and Remedy

CONSTANT TROUBLE was experienced with the steam piston of a high-pressure water pump; it was always getting loose and pounding. I was called on to see why

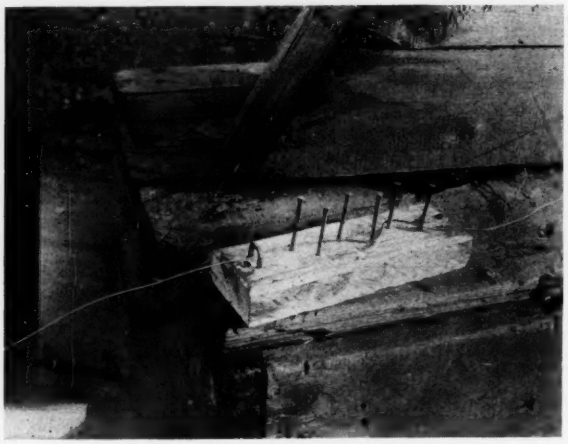


BRASS PISTON FITTED WITH STEEL BUSHING

it could not be made secure. On removing the piston and rod, I found that the piston was made of composition and the rod of forged steel. Right there was the trouble, due to the difference in the expansion of the 2 materials, under high steam temperatures. They told me that the old piston was cast iron, and had broken, as there was a brass foundry close by, they had one cast and machined there. It worked for a while, then got loose. They then placed washers under the piston rod nut and secured it, but after a few days it was loose again. As an iron foundry was not handy and the pump was needed, I made the composition piston do, with a steel bushing, as shown in the sketch. This is doing well, but I advised the purchase of a new piston of cast iron from the manufacturers of the pump. C. H. W.

Straightening Small Wire

IT IS frequently necessary around the plant to straighten out not a few feet of old wire, and when it happens to be full of numerous kinks it is a tiresome job. The photograph shows a handy and readily made jig that will straighten out small wire perfectly just as fast as it can be drawn through the device. An oak



SIMPLE JIG FOR STRAIGHTENING SMALL WIRE

block, 3 or 4 finishing nails and a staple are all the necessary parts. The writer made one for running some copper wire, and it came in very handy and convenient. The staple keeps the wire close to the base of the nails. The finer the wire and the more full of kinks it happens to be, the more nails can be used to loop and draw it around.

F. W. BENTLEY, JR.

U. S. CIVIL SERVICE COMMISSION announces an examination for laboratory assistant in ceramics, on Nov. 22, to fill vacancies in the laboratory of the Bureau of Standards, Pittsburgh, Pa., at salaries ranging from $900 to $1200 a year, and vacancies as they may occur in positions requiring similar qualifications. This examination is held to secure eligibles having technical training in the subject of ceramics, comprising the technology of structural clay products, refractories, and pottery. Subjects are general physics, French or German, practical questions in ceramics, education, training, and experience. Applicants must be graduates of or senior students in a course of ceramic engineering or ceramics at a technical school or college of recognized standing. Age, 18 yr. or over. Applicants must submit their photographs. Apply for Form 1312.

BEATRICE, NEB., is making plans for a power house to cost $5500, for municipal and private lighting.

Questions Answered and For Answer

Expert Help When In Trouble. If You Want Quick Answer Enclose a Stamp

Calculating Horsepower of Electric Motors

IF A 110-V. MOTOR running at a speed of 950 r. p. m. and delivering 20 hp. is connected across a 220-v. line, what will be its speed and what will be the current flow?

If I connect it across a 220-v. line, I double the number of ampere turns on the field and to pull the same load will take but 75 amp. The field strength being doubled, the motor should run at a higher speed to develop a counter electromotive force sufficient to limit the current flow to 75 amp.

Could this motor be used to pull 40 hp. if it had proper regulation and sufficient armature capacity?

2. To develop a given number of horsepower, do you not have to supply a current such that the product of the number of volts times the number of amperes, divided by 746 is equal to the desired number of horsepower? That is, for 10 hp. you would have to apply 75 amp. at 110 v. or for 20 hp., 150 amp.

I had a dispute with an electrical engineer over this question, he claiming a certain motor could be made to develop the same power at ½ amperage. E. K.

ANSWERS

IT IS DIFFICULT to predict what the action of a 110-v. motor will be when connected to a 220-v. circuit, unless one knows all about the characteristics of the machine.

Your assumption that the strength of the field would be double because of the double number of ampere turns, is correct, provided you are working with a field which normally has a low saturation.

You are probably aware that the magnetic circuit of a motor or dynamo reaches saturation at a certain point, and the addition of ampere turns beyond that point produces but comparatively slight increase in the strength of the field. Most modern motors are designed so that they work close up to this saturation point, and doubling the ampere turns on the field would not double the field strength.

Another point—it is not likely that the field winding would be able to carry twice its normal current without overheating, so that it would probably be unsafe to attempt to run under these conditions.

Assuming for an instant that doubling the field current would double the strength of the magnetic field, this would mean that a current of half the normal strength in the armature would give the same torque as under normal conditions,—that is, the same rotative pull.

With the field strength double, however, the speed of the armature would be half as great in order to give 110 v., you cannot possibly get 10 hp. for any less than since we must have approximately 220 v. counter electromotive force to prevent excessive current in the armature, the speed would have to come up to its normal amount. Of course, the counter electromotive force which must be generated is just sufficient so that the difference between it and the applied electromotive force will give a voltage drop which will overcome the resistance of the armature and force through the armature current needed to develop the required power of the motor.

In the case of 220 v. applied, since the current through the armature is to be only half that, or 110 v., the difference between counter electromotive force and 220 v. would be half as much as the difference between counter electromotive force and 110 v., under normal conditions. This will mean that the armature will run at somewhat higher speed for a 220-v. connection than it would for a 110-v. connection, but the difference would not be great.

The fact, however, that the field strength would probably not be doubled by doubling the ampere turns on the field would tend to increase the armature speed still further in order to generate the required counter electromotive force.

Opposing this tendency would be the fact, that a greater current than half the normal amount would be needed in the armature in order to develop the required horsepower, because of the fact that the field strength is not doubled.

The whole interaction of forces and results here is quite complicated and cannot safely be predicted without a careful study of the exact characteristics of the machine in question.

2. In regard to this question, the horsepower that a motor will deliver depends on the current times the electromotive force impressed. You cannot get something for nothing, and there is no possible way, when using 110 v. on a 110-v. motor, of getting twice the horsepower with the same current, or of getting the normal horsepower with half the normal current. If you have a 10-hp. motor and it requires 75 amp. at 110 v., you cannot possibly get 10 hp. for any less than 75 amp., except by increasing the impressed electromotive force. A. L. R.

Limiting Factors in Safety Valve Construction

RULES FORMULATED by the Board of Boiler Rules state that safety valves shall not exceed 5 in. in diameter with seat and bearing surface of the disc inclined at an angle of 45 deg. to the center line of the spindle. Give reasons for these 2 rulings. READER.

A. Due to the very nature of their functions, it is necessary that safety valves be designed and constructed so as to guard against all failure to operate. Making

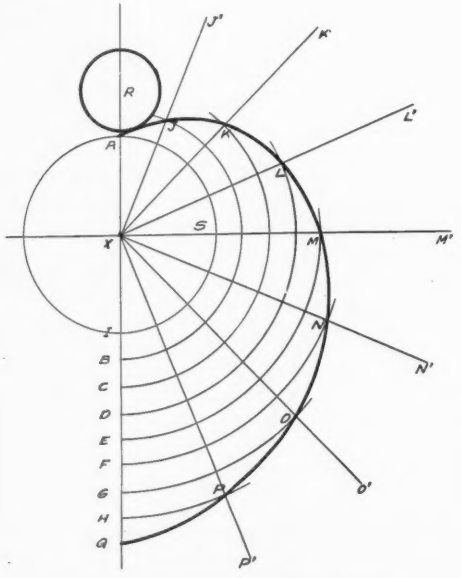
such valves greater than 5 in. in diameter tends to introduce mechanical defects, such as non-uniformity of metal in casting the parts of the valves, blow-holes, etc., so that the size of valves has been limited to 5 in.

Another reason for such limitation is that when an exceedingly large opening is made in a steam boiler under pressure, a sort of explosion takes place, causing the shell to be put under excessive strain. It, therefore, has been determined by experiment and operating statistics that, in order to obtain a reliable valve casting, free from non-uniformity of metal, blow-holes, etc., and to avoid the detrimental results occasioned by the opening of a large safety valve, the size of safety valves be limited to 5 in. The best bearing surface for the discs of safety valves is obtained when the seats make an angle of 45 or 90 deg. to the center line of the valve spindle. O. H. H.

A Cam Design

WILL YOU kindly inform how to design a heart cam having a 4-in. throw and using a 1½-in follower?
S. S. Y.

A. In the accompanying illustration let X be the center of the cam. Let A be the point at which the 1½-in. follower is at the lower end of the stroke. Draw semi-circle ASI and extend the diameter a distance IQ=4 in., or the required throw. Divide IQ into any number of equal parts (8 parts is convenient) as at B, C, D, etc., and divide the semi-circle by the same number of radii.



METHOD OF CONSTRUCTING A CAM

With X as a center and a radius equal to XB, describe an arc intersecting XJ at J. With the same center and a radius equal to XC, describe an arc intersecting XK at K. Continue this process through the points, L, M, N, etc.

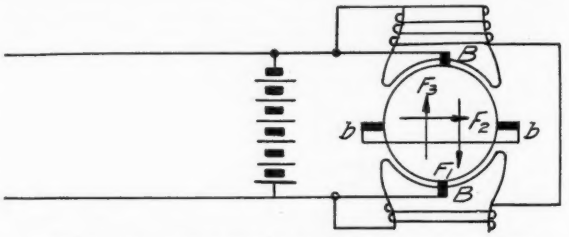
If the follower employed were pointed, these locations would serve as points on the cam outline; but when a roller is used, the position of the roller at various intervals in the rotation of the cam must be determined. This may be done by adding each of the distances XJ, XK, etc., the radius of the roller. With these points J^1, K^1, etc., as centers and with a radius equal to that of the roller, describe arcs. A curve drawn tangent to these arcs is the required cam curve. The other half of the cam is laid out in the same manner.
W. P.

The Rosenberg Electric Generator

WHAT IS the principle of operation of the Rosenberg dynamo? Where is it used? E. J. K.

A. The Rosenberg electric generator is a self-regulating, variable-speed machine used in connection with storage batteries in train lighting systems.

As shown in the diagrammatic sketch herewith, the windings are shunt connected and with a constant battery voltage, the shunt field sends across the air gaps a flux, F_1, which is approximately constant. Due to the revolving of the armature between the field poles, the conductors on the surface of the armature cut this flux



SCHEME OF CONNECTIONS EMPLOYED IN ROSENBERG ELECTRIC GENERATOR

and an electro-motive force is generated between brushes bb, but none between brushes BB. The former being short-circuited, a current flows through the armature and creates an armature field flux, F_2.

Since the armature conductors cut this flux, F_2, there is an electromotive force established between brushes BB with a resulting flow of current, I, in the external circuit. This current, I, sets up a flux, F_3, which opposes flux F_1, but can never exceed it, so that I cannot exceed the value at which the armature ampere-turns per pole equal the shunt field ampere-turns per pole. The direction of the flow of current I is independent of the direction of rotation of the machine. O. H. H.

Lost Motion in Duplex Steam Pumps

WHY ARE the steam valves in a duplex pump provided with lost motion? I know that if this lost motion is decreased, it will shorten the stroke and if it is increased, it will lengthen the stroke. I also know that by having this lost motion, the piston is brought to a dead stop at the end of each stroke, thus giving the water valves a chance to seat.

In the case of a single-acting pump, it is not necessary to bring the piston to a dead stop in order to give the valves a chance to seat. C. J.

A. In order to get the reason for lost motion in the duplex pump valve, you must consider the way the pump acts. You know, of course, that the pump takes steam full stroke. It must, therefore, have the valve practically wide open when the steam piston starts to move, and this valve must remain wide open until the

piston has practically completed its stroke. This means that the steam valve must stand still while the pump is making its stroke.

If there were no lost motion, the steam valve would have to move continuously back and forth. This would mean that to get the port wide open before the steam piston starts to move, it would be necessary to begin to open it a good while before the piston starts to move. Then the valve would have to travel far beyond the edge of the port so that it might move to its extreme position and back a considerable distance before it began to close the port, which would mean a total valve travel of 3 or 4 times as much as at present, with a consequent increase in the work to move the valve, and an awkward increase in the size of the mechanism which drives the valve.

By using the lost motion, the valve is opened quickly just before the piston starts to move; then it stands still with the port wide open until the piston has nearly completed its stroke, when the valve is quickly closed again.

Another thing, the object of the duplex pump is to secure continuous flow of water in the discharge pipe and smooth running of the pump. This is best secured by having one piston moving at a time, the pistons working alternately, and in order to allow of this standing still of one piston, with the steam valve closed, it is necessary to have the lost motion so that the idle piston may remain with the steam port closed and the exhaust port open.

So far as the single-cylinder pump is concerned, there is lost motion in the valve there; but it is in the auxiliary pilot valve, not in the main steam valve. As a matter of fact, the piston of the single-cylinder pump does slow down at the end of the stroke and stop, and much thought is given to designing a valve system which will permit this. A. L. R.

Expressing Pump Dimensions in Metric System

I HAVE a Worthington duplex oil-fuel pump with the following figures marked on the name plate:

76 x 51 x 76
3 x 2 x 3

What does the upper group indicate?

2. We wish to install a motor-driven air pump to run the above-mentioned pump when starting up the boilers and until the steam pressure has reached 25 lb. How much air pressure should be carried? Would 50 to 60 lb. be sufficient?

3. How large a reservoir should we have for the storage of this air? C. F. G.

A. The dimensions 76 by 51 by 76, and 3 by 2 by 3, evidently mean 76 mm. diameter of the steam cylinder, 51 mm. diameter of oil cylinder, and 76 mm. stroke. Dimensions 3 by 2 by 3 are the same, respectively, except in inches.

2. You do not state in this question what pressure it is necessary for you to carry in the oil burner. A pressure of 50 to 60 lb. in the air receiver would give you an oil pressure between 112 and 135 lb., not counting any loss due to friction.

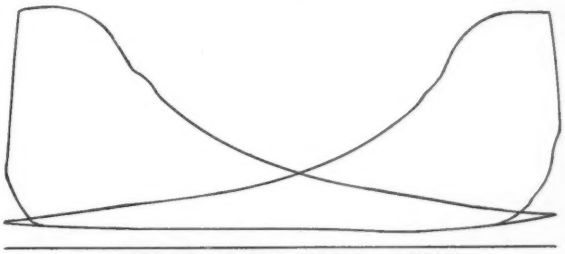
We presume that you ordinarily run this pump with steam at full boiler pressure, and we are of the opinion that you should carry the same air pressure as your boiler ordinarily carries steam pressure.

3. In regard to the size of air receiver, I would state that this cannot be too large, but would suggest that one having a capacity of 25 cu. ft., say 2½ ft. in diameter by 5 ft. high, should be able to serve your purpose satisfactorily. R. E. T.

Indicator Card Criticism

KINDLY CRITICISE the indicator diagram shown herewith, which was taken from a 14 by 36-in. Murray Corliss engine running at a speed of 110 r. p. m. Advise as to the changes necessary to improve the diagrams. J. D. W.

A. The leaning in of the admission line at both ends of the card would indicate that the steam valves are opening a trifle late. Release also occurs late. Advancing the eccentric somewhat would tend to correct these conditions.



MURRAY CORLISS ENGINE DIAGRAM

An excessive rounding off of the point of cutoff indicates that the steam valves are not closing quickly enough, although this effect is probably caused in part by the late action of the steam valves in general. It would be well, however, to examine the dashpots to determine if they are operating properly. W. P.

IN THE MINDS of nearly all thinking men, the question is frequently arising what industrial conditions will prevail after the European war is ended. The only thing which seems certain is that some great readjustment, whether rapid or gradual, will be necessary, and the problem of how to effect this with the least disturbance of industries is serious. The countries in Europe, even while engaged in the great struggle, are giving attention to this problem and laying plans for the future, and it is only the part of good sense for those interested in the future welfare of this country to do likewise.

With this end in view, the Efficiency Society, of New York City, is calling a conference to meet in that city January 25, 1917, to discuss the situation, and to try to arrive at an understanding of present foreign conditions abroad and at home, to look forward to the future and to endeavor to outline a course of action to secure the combined effort of employers and employes toward bringing about a satisfactory and easy rearrangement of industrial conditions as future emergencies require. Those who will present their views at the conference are drawn from the ranks of both employers and workers, and the deliberations of the conference should be productive of much helpful thought.

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Editorial Comments

Modern mercantile establishments require modern mechanical equipment; advancement in one has been made possible by advances in the other. No more striking proof of this is found than in the Boston Store of Chicago. Here we have a growing department store increasing its customers and trade largely through conveniences and comforts afforded its patrons by the mechanical equipment. Adequate elevator service; fresh, clean air; well distributed, restful electric lighting; sanitary refrigerating methods; pure, cold drinking water in sanitary fountains; facilities for rapid delivery of purchased articles—all these and many other services are the products, at least in part, of the power plant, some special features of which are described in the leading article of this issue.

Many of our troubles with leather belting are due to a lack of appreciation on the part of the operator of some fundamental principles of installation and care. Mr. Richards in this issue gives us some suggestions which have come to him through years of experience with belting and which should aid us in solving belt problems.

Before condensers are installed much guess work is frequently indulged in by the man in charge as to the amount of cooling water that must be handled. Mr. O'Neill gives us practical formulas for making the needed calculations and then "sugar coats" them by presenting a chart from which the desired information can be obtained without resorting to mathematical calculations.

The wonderful improvements in incandescent electric lamps made during the past five years is apparently only the foundation upon which future investigations will be based. There is still room for experiment with different metals for filaments and gases for filling bulbs as well as arrangements of filaments. We learn something of what has been done abroad along these lines from Mr. Blakey's article in this issue.

Many engineers, thoroughly familiar with the mechanics of electric generators, experience difficulty in understanding how small changes in operating conditions change so greatly the electrical results. The influence of speed upon compounding and commutation is discussed by Mr. Fox, who points out some interesting generator characteristics due to the variation of magnetic field.

Until recently little information has been available in this country in regard to the results obtained from Diesel engines in ordinary power plant practice. In this issue are published the results of some investigations put into chart form for convenient reference and comparison with other forms of prime movers. Other charts and data in the Practical Reference Tables will save a great amount of calculating if preserved for use when needed. Get this saving habit. It's the forerunner of a bank account.

Let a need or want be felt and some mind is set to work devising a method or means for supplying the desire. We are reminded of this truth by reading the descriptions of newly developed apparatus published in this issue. The two popular slogans, "safety first" and "efficiency," are probably the original incentive for development of all these appliances. The more we keenly desire, the faster will be our development.

Piping in Power Plants

THE problem of correct piping has become extremely important, yet there is a decided lack of printed information on the subject necessitating the loss of valuable time in extensive research.

Materials

THE FIRST consideration in treating of Power Plant Piping is the materials which may be used and their properties, including steel, wrought iron, cast-iron, brass and copper—the uses for which each material is best suited, and the properties of these various materials. This will be fully treated, with tables showing the strengths, and data giving the resistance to pressures, bending strains and chemical action.

Joints and Fittings

JOINTS IN piping will then be considered, covering the fittings and methods of making tight joints in both screwed and flanged construction; and following will be a consideration of methods of making branches and turns, including the use of screwed and flanged fittings, long bends and welded nozzles.

Expansion

IT IS important that every line subjected to high temperatures should have provision for expansion. The different methods of taking care of this will be taken up, including the method for calculating the amount of expansion to be provided for, and the use of swing joints, different forms of bends and slip joints, and the proper method of anchoring.

Coverings and Supports

A SOURCE of great loss in both steam and refrigeration piping is the heat transmitted through the pipe, either out or in, as the case may be. Treating of pipe insulation, the amount of heat loss to be expected will be shown, the value of different kinds of covering materials, and their proper use for heat and cold insulation.

Installation

PRACTICAL hints on installation of piping systems will be given, including measurement for lengths of pipe, listing of material, cutting, threading and making up, with the special tools required for such work.

Water Pipes

TREATMENT of water piping will take up the resistance to flow of water in pipes, and the allowance that must be made for loss of head at different velocities and in various sized pipes.

The arrangement of feed lines, for boilers, including connections to the boilers, to heaters, economizers and other auxiliary apparatus, will be considered.

Water piping for building service will be treated, including the connections to hot water heaters, toilets and wash rooms, air washers, elevators and drinking water system. For fire service, special piping is, of course, necessary, and the arrangement will be shown for proper connection to pumps, hydrants and hose lines, and the installation for roof tanks and sprinkler systems of both dry and wet type.

Steam System

PASSING to Steam Piping, the system will be taken up in the order of the use of steam from the boiler. First will be considered the outlets from the boilers, with the valves needed and the proper connections to the steam mains. Next, the headers and mains, showing the arrangement on different systems, with the method of taking off branches to supply prime movers, proper draining of mains and of branches, provision of outlet traps and valves to keep the drips free of water, proper use of receivers and small pipe lines where high velocity is desired.

Arrangement of auxiliary headers and branches to supply pumps, compressors, stoker engines and other small apparatus; and the provision of steam supply for special services.

Exhaust steam piping will next be treated, showing the proper provision of piping and arrangement for the necessary valves for atmospheric and condenser exhaust—connection to the heating system and to feed water heaters, both open and closed types.

Oil Pipes

OIL PIPING will take up the arrangement of the system, including the storage tank, oil pumps, supply tank, filters and supply system to the different journals; showing the proper connections for a central supply system, for the use of individual lubricators, for force feed systems, and a special section will be devoted to the proper arrangement of piping for fuel oil system.

Compressed Air Supply System

UNDER the subject of Air Piping, complete layout will be given for the air compressor, through the storage tank, including automatic compressor control, and on through the supply mains for different purposes.

Refrigeration Systems

PIPING in the Ammonia Plant will cover the special requirements as to material and fittings, the arrangement of lines to and from the ammonia compressor, the proper run of pipe and valve required for connection to the condenser, purifier, expansion coils and other included apparatus; and in the case of the absorption system, the proper connections from generator to rectifier, receiver, expansion coils, absorber, equalizer and return to generator.

It is notable that there is, at the present time, no comprehensive source of information on the subject of Power Plant Piping, which deals with both details and general arrangement, and it will be the purpose of the January 1, 1917, specialized issue of Practical Engineer to supply this need and to put in clear, concise form, the information available on all kinds of power plant piping, and to gather all new information which can be secured from the various sources available, so as to make this issue a complete treatment of the subject to date. No effort will be spared to include just the information that every engineer is constantly seeking and which he has heretofore been unable to find without long and troublesome search.

Power Apparatus in Shop and Market

New Ideas In Making, Buying and Selling

Motor Rotation

IN THE constantly increasing efforts of power companies to afford all possible protection to life, machinery and manufactured product, the reverse-phase relay has been called upon to play an important part. These companies have been quick to take advantage of the protection thus afforded against the serious results attendant upon alternating-current motor reversals, particularly when these motors are used in connection with elevators, hoists, conveyors, cranes, machine tools and textile machinery. In fact, in some large cities the use of reverse-phase relays in this application has been made compulsory.

Among the common causes of accidental phase reversal are the interchanging of wires when repairs to cables are made, involving a temporary discontinuing

GENERAL ELECTRIC INSTANTANEOUS CIRCUIT-OPENING REVERSE-PHASE RELAY WITH HAND RESET CONTACTS

of the service. This may also happen when additional switching apparatus is installed or when additional service wires are connected.

The new reverse-phase relay illustrated on this page and manufactured by the General Electric Co., is made in both circuit-opening and circuit-closing styles. Both types of contacts are equipped with toggles so arranged that there is no tendency for the contacts to open or close until the toggle has buckled, the contacts then, by means of a small spring, being quickly thrown to the desired position. The type of contacts required for any installation will depend on the method of tripping out the motor switch.

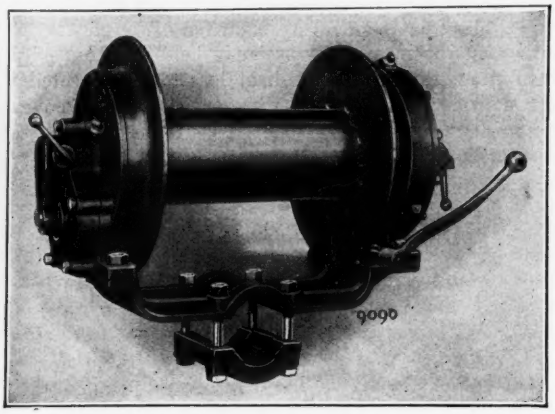
The relay operates on the same principle as a squirrel-cage induction motor, the operating coils corresponding to the stator and a hollow aluminum cylinder, connected to the contacts, corresponding to the rotor. The cylinder (plunger) does not rotate, but moves in a straight line, either up or down, depending upon the phase rotation. When one of the phases of the line is reversed, the plunger moves and operates the circuit-opening or circuit-closing contacts.

Relays can be furnished for 2-phase or 3-phase service with either current or potential windings, depending upon the amount of current and the voltage of the circuit.

New Model Little Tugger Hoist

FOR the use of those who prefer manila rope to wire rope for light hoisting and hauling, the Ingersoll-Rand Co. has brought out a new model little Tugger Hoist which is designated No. 11.

The square piston, reversible driving engine, automatic lubrication, enclosed gearing, drum release clutch and worm operated band brake are essentially the same as in the No. 1 model which was described on page 999,



LITTLE TUGGER HOIST SUITABLE FOR THE USE OF MANILA ROPE

Practical Engineer, Oct. 1, 1914. The main differences are in the diameter and length of the drum, the width of the flanges and, necessarily, the main frame and overall dimensions.

The new No. 11 Little Tugger has a hoisting drum 7 in. in diameter by 17 in. long with 5-in. flanges. This accommodates 300 ft. of ⅞-in. manila rope. The maximum capacity of this hoist is conservatively rated at 600 lb. The weight of the hoist itself is 358 lb. It is 21½ in. long, 31¼ in. wide and 23 in. high.

Like the No. 1, the No. 11 Little Tugger is built for operation both by compressed air and steam. The standard clamp fits a 4½-in. diameter column or pipe but by removing the clamp the hoist can be readily bolted directly to any convenient support, timber, flooring, etc.

Although designed primarily for underground work, it is recommended by the manufacturer for all-around hoisting, hauling and handling in mines, tunnels, quarries and industrial plants.

Bakelite Micarta-D Gears and Pinions

A NON-METALLIC gear material has recently been placed on the market by the Westinghouse Electric & Mfg. Co., of East Pittsburgh, Pa., under the name of Bakelite Micarta-D. This is a product of heavy duck bonded together with Bakelite by heating while under an enormous pressure. It is as strong as cast iron, is unaffected by atmospheric changes, is vermin proof, and can be stored indefinitely without shrinking or other deterioration. It can be used for gears that have to operate in oil, without any signs of swelling. In most cases, neither bushings or shrouds are required, as the material is self supporting. Where, however, the requirements are unusually severe or where the diameter of the gear is several times the width of the face, end plates may be advisable, but even in such cases the teeth need not be shrouded, and the width of the gear is determined only by the power to be transmitted. It meets all the requirements of a metallic gear, but reduces vibration and noise to a minimum.

Bakelite Micarta-D machines readily take a good polish, machining best at high speed and with plenty of rake to the tool. It can be machined in any direction and drills and taps readily. The same tools are used as for steel when cutting teeth, but an increase in cutting speed of 25 per cent and an increase of feed of 50 per cent may be used. The depth of material from the root of the tooth to the bore should never be less than the depth of the tooth. In other words, from bore to root of tooth should equal or exceed the distance from root of tooth to face of gear.

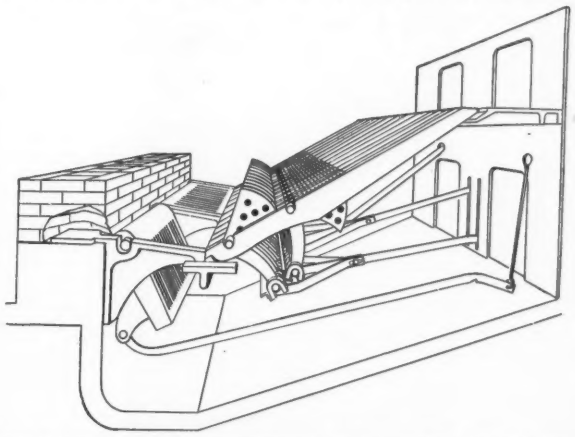
Bakelite Micarta-D material has a tensile strength, parallel to laminations of 10,000 lb. per sq. in.; a compression strength of 30,000 lb. per sq. in. perpendicular to laminations, and of 17,000 lb. per sq. in. parallel to laminations; a transverse strength of 17,000; a coefficient of expansion per inch per degree Centigrade, of 0.000,02 in. in the direction parallel to laminations and of 0.000,085 in. in the direction perpendicular to laminations. It has a specific gravity of 1.4, weighs 0.05 lb. per cu. in., and has a water absorption of 0.25 to 2 per cent by weight, depending upon the relative amount of edge surface exposed. Shrinkage and oil absorption is practically zero.

The long life of Bakelite Micarta-D gears has been proven under the most severe service conditions and in a large variety of applications, such as timing gears for automobiles, main driving gears for punch presses, boring mills, engine lathes, pressure pumps, crane motors, textile machinery and general machine shop service.

The National Stoker

DISTINCTIVE features of this stoker, which is manufactured by the M. A. Hofft Co., of Indianapolis, Ind., are its ability to burn the cheapest grade of fuel, such as coal slabs, offal and even the refuse from wood working factories, and still conform to the requirements of the most rigid municipal smoke ordinances; an efficiency equal to that of the more expensive automatic stokers; and its unusual simplicity.

As shown in the accompanying illustration, the National Stoker consists primarily of a dead plate cast integral with the furnace front, an inclined grate built up of stationary herringbone bars and 2 sets of fuel pushers, and a dump plate at the rear. The fuel pushers, each set of which is made up of a series of sector-shaped bars pivoted on trunnions resting in recesses cast in the stationary bars, are operated by levers



THE NATIONAL STOKER, SHOWING ARRANGEMENT OF GRATES, FUEL PUSHERS AND DUMP PLATES

extending to the front of the furnace. Due to the action of these pushers and the incline of the grates, the burning fuel is gradually moved toward the rear until, when partially consumed, it reaches the dump plate where it is allowed to remain until entirely consumed. It is then dumped into the ash pit by means of a second set of levers which also extend to the front of the furnace.

Frequent opening of the firing doors is unnecessary as comparatively large quantities of fuel are placed on the dead plate at one time. Here it is allowed to coke and after the volatile gases have been distilled off, it moves onto the grate bars and by means of the 2 sets of pushers, onto the dump plate. The coal, therefore, lies on the stoker in 3 stages; the coked, the green and the incandescent. By this process, perfect combustion is obtained before the gases come into intimate contact with the cool boiler surfaces.

Air for the combustion of the fuel is obtained through the ash pit as shown.

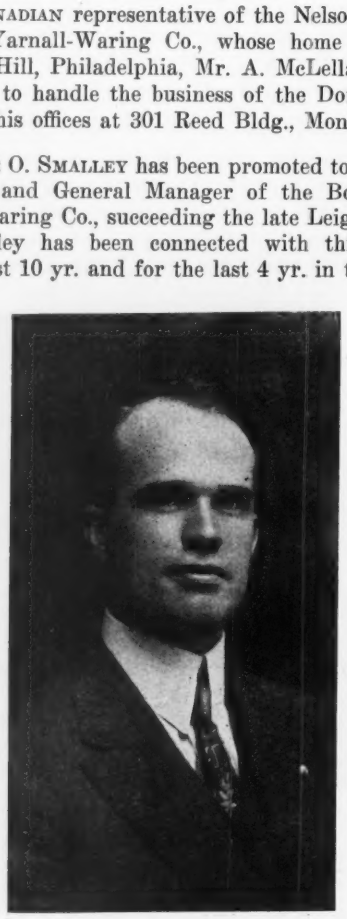
VASSAR, MICH., has voted a bond issue of $25,000 for the installation of an electric light and water system.

UNIVERSITY OF CALIFORNIA has let a contract for a new power plant at Berkeley to C. C. Moore & Co., of San Francisco, for $49,589.

News Notes

As Canadian representative of the Nelson Valve Co. and the Yarnall-Waring Co., whose home office is at Chestnut Hill, Philadelphia, Mr. A. McLellan has been appointed to handle the business of the Dominion, and will have his offices at 301 Reed Bldg., Montreal.

George O. Smalley has been promoted to First Vice-President and General Manager of the Bound Brook Oil-less Bearing Co., succeeding the late Leigh S. Bache. Mr. Smalley has been connected with this company for the past 10 yr. and for the last 4 yr. in the capacity



of Assistant General Manager and Assistant Treasurer and is, therefore, thoroughly conversant with the method of both the sales and production departments of this rapidly growing business.

Millersburg, Pa., Light, Heat & Power Co. has purchased the light plants at Newport and Mifflin, and will build an entire new plant on the site of the present building east of the borough limits. Machinery has been ordered, including 2 generators and Corliss engines and boilers. Lines will be extended to Halifax, also across the Susquehanna River, to furnish power and light for Newport, Mifflin, Millerstown, New Bloomfield, Port Royal and Thompsontown.

In the Lowellville, O., power house of the Mahoning & Shenango Co., a boiler tube blew out in a battery of boilers, and this happening just before the rush hours for the street cars and the peak load for the lighting, made it necessary to draw the fires and to shut down the street car lines and the lighting system in Youngstown during this time of heaviest traffic. Damage was repaired and service restored by 10 o'clock.

An addition is to be built to the Lowellville power house which will increase its capacity by the addition of a 20,000-hp. turbo-generator, making the total capacity 60,000 hp. Construction is in the hands of the Stone & Webster Engineering Corporation. The generating unit will be furnished by the General Electric Co., and the battery of boilers by Babcock & Wilcox Co., equipped with Taylor automatic stokers. A new concrete smokestack will be erected to take care of the increased boiler plant.

Memphis, Tenn., has authorized a bond issue of $1,500,000 for building a municipal light plant.

Connecticut Co., of New Haven, Conn., has been granted permit to erect a 2-story power house on Grand Ave., 78 by 148 ft., at a cost of $250,000.

James S. Kirk Soap Co., of Chicago, is preparing plans for a new power house for a factory now in process of erection. The matter is in charge of E. C. and R. M. Shankland, consulting engineers, of Chicago.

Franchise has been granted to James G. Rossman, president of the Stuttgart, Ark., Public Service Co., for the erection of a modern plant to supply water and electric lighting.

Work has been commenced on a new power plant for the Mansfield Electric Light & Power Co., at Mansfield, O., located southeast of Mansfield, and is being pushed rapidly.

The city of Marlow, Okla., is contemplating improvements to the electric light plant and water works, including the erection of a power house and installation of engine, generator and other equipment.

Buckeye Engine Co., Salem, O., has broken ground for the erection of a new power house, the old engine room and boiler house being torn down and a new 2-story brick building, with new equipment, will be erected in its place.

Improvements are to be made in the plant of the Seeley Electric Co., of Spencer, N. Y., the plant being enlarged by the addition of a new engine generating unit and equipped with the necessary switchboard and other accessories.

At Cleveland, O., Fielder Sanders, municipal traction commissioner, has recommended to the City Council that the Cleveland Railway be permitted to contract with the Cleveland Electric Illuminating Co. for power. This will result in the abandonment of the Cedar Ave. power house and the construction of a substation at an estimated cost of $250,000.

U. S. Civil Service Commission announces examinations, Nov. 21, as follows:

Petroleum Technologist, to fill vacancies in the Bureau of Mines, for service in the field, at salaries ranging from $2500 to $3000; apply for Form 2118.

Radio Draftsman, to fill vacancies in the Navy Department, Washington, D. C., at salaries ranging from $3.04 to $6 a day; apply for Form 1312.

Expert Aeronautical Aid, to fill a vacancy at $13 a day in the Department of Construction and Repair, Navy Yard, Washington, D. C.; apply for Form 2118.

Assistant Petroleum Engineer, to fill a vacancy in the Bureau of Mines, at a salary ranging from $1800 to $2500; apply for Form 2118.

Designing Mechanical Engineer, to fill a vacancy under the Board of Engineers, U. S. Army, New York, N. Y., at $2100 a year; apply for Form 2118.

These tables contain data especially worked out or carefully selected that are vital to your work. You may need them at any time and should preserve them. A handy, serviceable, loose-leaf cover in which these tables fit exactly, will be sent you for 30 cents in currency or stamps.

PRACTICAL ENGINEER

COST CURVES CONSERVATIVELY REPRESENTING CONDITIONS EXISTING IN THE AVERAGE ELECTRIC GENERATING PLANT CONSTRUCTION COSTS AND FIXED CHARGES ON VARIOUS SIZED DIESEL ENGINE ELECTRIC PLANTS

PRACTICAL ENGINEER

CHART GIVING HIGH AND LOW PRESSURE CYLINDER DIAMETERS FOR CERTAIN PUMP DUTY

TOTAL HEAD IN FEET
PISTON SPEED FEET PER MINUTE
CAPACITY IN MILLION GALLONS PER DAY
STEAM PRESSURE POUNDS PER SQ. INCH
HIGH PRESSURE CYLINDER DIA IN INCHES

ELECTRICAL WORLD

PRACTICAL ENGINEER

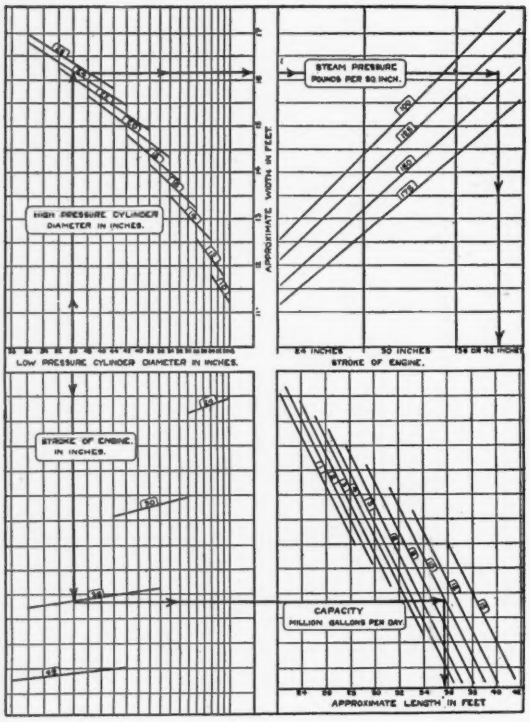
SUPPLIES AND REPAIRS COST CURVES FOR DIESEL ENGINES

PRACTICAL ENGINEER

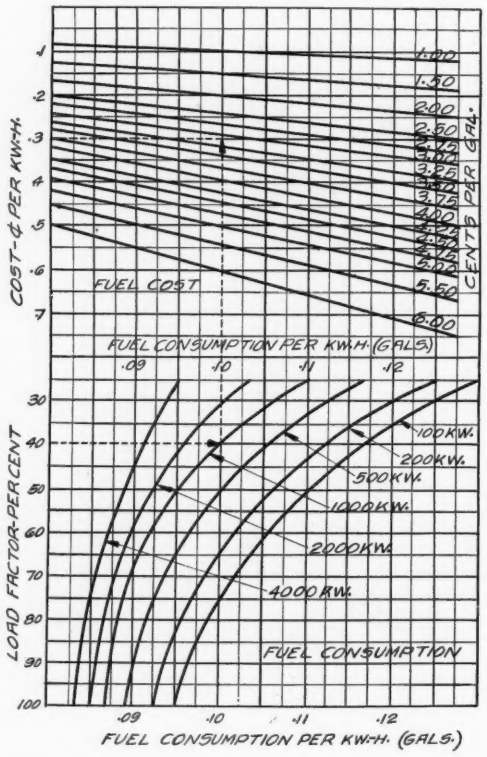
SUPERFICIAL AREA OF BOILER TUBES
In Square Feet

Tube Dia. in.	Tube Length						
	8 ft.	10 ft.	12 ft.	14 ft.	16 ft.	18 ft.	20 ft.
2	4.188	5.235	6.283	7.330	8.377	9.425	10.470
2-1/2	5.236	6.545	7.854	9.163	10.472	11.781	13.090
3	6.283	7.854	9.425	10.996	12.566	14.137	15.708
3-1/2	7.330	9.163	10.996	12.793	14.661	16.448	18.326
4	8.378	10.472	12.566	14.658	16.755	18.846	20.944
4-1/2	9.425	11.781	14.137	16.464	18.849	21.168	23.562
5	10.472	13.090	15.708	18.326	20.944	23.562	26.180
6	12.566	15.708	18.850	21.991	25.132	28.274	31.416

CHART GIVING STROKE AND FLOOR SPACE OF CROSS-COMPOUND PUMPS UNDER DIFFERENT CONDITIONS


HIGH PRESSURE CYLINDER DIAMETER IN INCHES.
LOW PRESSURE CYLINDER DIAMETER IN INCHES.
STEAM PRESSURE POUNDS PER SQ. INCH.
APPROXIMATE WIDTH IN FEET
84 INCHES
90 INCHES
STROKE OF ENGINE.
STROKE OF ENGINE IN INCHES.
CAPACITY MILLION GALLONS PER DAY
APPROXIMATE LENGTH IN FEET

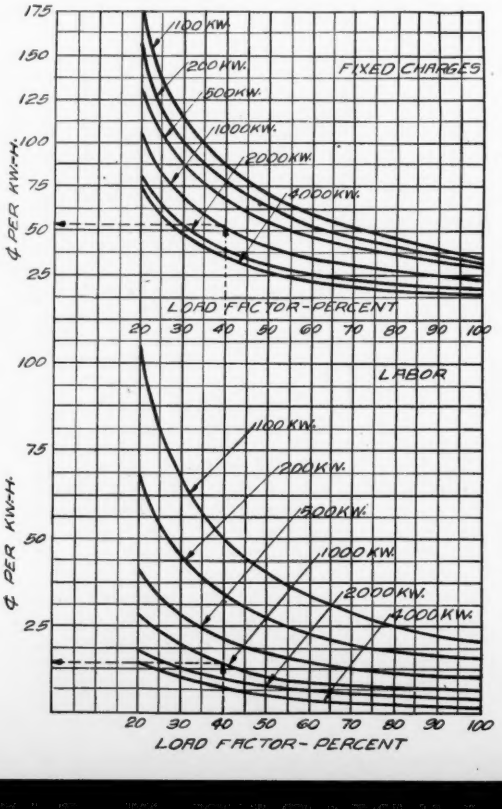
FUEL CONSUMPTION AND COST CURVES ON DIESEL ENGINES



SUPERFICIAL AREA OF HALF OF SHELL In Square Feet

Diam. in inches	Length of Shell									
	8 ft.	10 ft.	12 ft.	14 ft.	16 ft.	18 ft.	20 ft.			
30	31	39	47	55	63	71	78			
36	38	47	57	66	75	85	94			
48	52	63	75	88	101	113	126			
54	57	71	85	99	113	127	141			
60			94	110	126	141	157			
66			104	121	138	155	173			
72			113	132	152	170	189			
78					163	184	204			
84					176	198	220			

FIXED CHARGES AND LABOR COST CURVES FOR DIESEL ENGINES



U. S. CIVIL SERVICE COMMISSION announces an examination, Nov. 28, for mechanical draftsman, to fill vacancies as they may occur in this position in the office of the Chief of Ordnance, War Department, Washington, D. C., at entrance salaries ranging from $1000 to $1200. Applicants must have had at least 3 yr. experience as mechanical draftsman, or must be graduates of a technical school, and must give the names and addresses of not less than 2 or more than 5 persons who can testify regarding technical training and experience. Apply for Form 1312.

ARRANGEMENTS are under way for the holding of a meeting of representatives from all states and cities interested in boiler legislation, at the Willard Hotel, Washington, D. C., during the week of December 4. This meeting has been called by the Industrial Commission of the State of Ohio, with the object of formulating some plan for securing uniform boiler legislation and uniform inspection laws.

Thos. E. Durban, chairman of the Administrative Council of the American Uniform Boiler Law Society, has co-operated with the Commission in securing representatives, and has promises that representatives will be sent by the States of Louisiana, Texas, Illinois and Pennsylvania, and from the cities of Little Rock, Ark., St. Louis, Mo., Chicago, Ill., and Detroit, Mich.

Many other acceptances have been received by the Industrial Commission direct.

Mr. Durban reports that the Safety Council of Philadelphia has decided on the adoption of the A. S. M. E. Code in its entirety to replace the old Philadelphia rules which have been in existence since 1868. This is a great victory as the Philadelphia Code is the oldest set of boiler rules in the United States and has been, heretofore, considered as standard in many other communities.

The National Branch of the Engineering Society of the South is making an effort to have the A. S. M. E. Code adopted in the city of Nashville and the State of Tennessee.

Catalog Notes

THE NATIONAL STOKER, manufactured by M. A. Hofft Co., of Indianapolis, Ind., is described in a booklet from that company, with illustrations showing the installation made with flush front setting and with a semi-dutch oven.

DEFENDER Automatic Regulator Co., of St. Louis, Mo., has just published Bulletin G illustrating and describing Defender Model E and F, 12 and 24-hr. gas collectors; and Bulletin I, dealing with draft gages, draft gage boards and hoods, and pet cocks.

CATALOG NO. 32, superseding Bulletin No. 31, of Erie Pump & Equipment Co., Erie, Pa., gives the important structural features of Erie Class M volute centrifugal pumps and illustrates them by halftones and sectional drawings. These pumps, which are made in 5 styles, are described as rugged pumps of simple construction with the smallest possible number of wearing parts. Directions are given for installation, with notes on piping, lubrication and priming; also a discussion of steam engines as prime movers for driving centrifugal pumps, some data for pumping problems and a table of theoretical horsepower to raise water to different heights.

THE AMERICAN STEAM GAUGE & VALVE MFG. CO. has just issued its Illustrated Catalog No. 65 describing power plant specialties of the company's manufacture, including gauges, valves, indicators, steam traps and other appliances for governing, indicating, measuring, recording and controlling steam, water, air, gas, oil, ammonia and other pressures.

FROM LINK-BELT CO., of Chicago, we have just received 2 new booklets describing the modern coal and ashes handling machinery which the company recently installed for the Victor Talking Machine Co., at Camden, N. J., and for the W. H. Grundy Co., Bristol, Pa., respectively.

TRIMO PIPE wrenches, pipe cutters, basin wrenches and monkey wrenches are described in a new catalog issued by the Trimont Mfg. Co., of Boston,

Mass. The catalog also contains a chart for determining the length of a 45-deg. offset pipe which will be found convenient for pipefitters.

THE SPIRIT OF CAUTION is a pamphlet sent out by the National Affiliated Safety Organizations, giving suggestions in regard to precautions about hiring of workmen for various occupations, to make sure that there is no weakness which unfits them for the work, and other safeguards which the employer may well use to avoid accidents and dangers.

IN CONNECTION WITH its courses, the International Correspondence School, of Scranton, Pa., has an interesting manual of information for students, which is sent out to them with the first lessons. It gives helpful suggestions for studying, for writing out answers to questions, for asking about special points, and some hints on the aid which the schools give to students in securing positions.

EXPERIMENTS CONDUCTED at the Engineering Experiment Station of the University of Illinois have established a relationship between the ash content of bituminous coal and its specific gravity which makes possible rapid estimation of the ash and moisture content. These tests have also shown that a knowledge

of the specific gravity of coal simplifies the problems of estimating tonnages underground and in storage, and of determining the adaptability of coal to treatment by the washing process.

The experiments were made by M. L. Nebel and the results are published as Bulletin 89 of the Engineering Experiment Station, copies of which may be secured upon request from W. F. M. Goss, Director, Urbana, Ill.

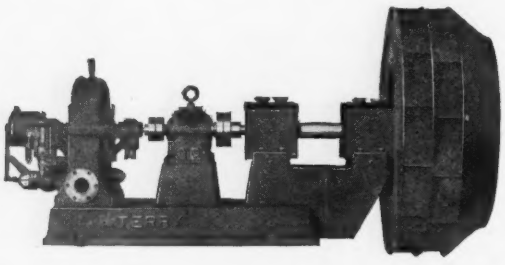
SELF-EQUALIZING EXPANSION joints, made by E. B. Badger & Sons Co., of Boston, are described in a new booklet from that company. They are one-piece corrugated copper joints with equalizing rings for distributing the expansion equally on all the corrugations.

CONCRETE HOUSES and Why to Build Them, a pamphlet published by Portland Cement Association, 111 W. Washington St., Chicago, discusses the architectural possibilities of concrete and the systems of construction that have been developed.

Two accompanying pamphlets give suggestions for concreting in cold weather.

Trade Notes

SIMPLICITY OF OPERATION and reliability of steam turbines make them especially suitable for boiler-room service; but their relatively high speed has until recently prevented their being extensively used for driving induced draft fans, as such fans, on account of the large volumes handled, are usually of relatively slow speed.



With the perfection and general adoption of high-speed reduction gears, turbine drive for induced draft fans is becoming more generally used, and a considerable number of geared turbine-driven induced draft fans are now in operation.

The illustration shows a typical unit; the fan housing is not shown. The turbines on these units were built by the Terry Steam Turbine Co., and the fans were built by the Green Fuel Economizer Co.

FOR INSTALLATION in the Curtis Bay substation at Baltimore, the B. & O. Railroad Co. has purchased from the Westinghouse Electric & Mfg. Co. of East Pittsburgh, Pa., 3 500-kw. rotary converters; 3 500-kv.a., oil insulated, self-cooling, 3-phase, 25-cycle, 13,200-v. high-tension, rotary low tension, transformers; 4 50-kv.a., single phase, 25-cycle, 13,200/550-v. transformers, and one 17-panel switchboard. This substation will supply energy to the Curtis Bay coal pier, one of the largest coal piers in the country. Energy will be furnished to the substation by the Baltimore Consolidated Gas & Electric Co.

PRACTICAL ENGINEER

Trade-mark, Reg. U. S. Pat. Off.

PUBLISHED ON THE FIRST AND FIFTEENTH OF EACH MONTH.

SEMI-MONTHLY

Subscription price in advance in the United States, Mexico or united possessions, $1.00 a year.

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Other specified positions, regular rate plus 10 to 50 per cent.

Stippled plates used, but no heavy, black and white plates.

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Advertisements in this section are inserted under regular headings.

No display type allowed, but the first three words may be set in capital letters.

About nine words make a line. Minimum space sold, two lines.

Under classification "Position Wanted," advertisements not exceeding four lines will be inserted once for subscribers free of charge.

All copy should be received at Chicago office 18 days before date of publication.

Circulation of this issue, 22,500.

Technical Publishing Co.

537 S. Dearborn Street

Chicago

Position Wanted

POSITION WANTED—Young man, age 28, as engineer in New York or Brooklyn. Hold marine, stationary and refrigeration license. Day work, 8-10 hours, desires to go to school nights. Write for particulars. Box 452, Practical Engineer, 537 S. Dearborn St., Chicago, Ill. 10-1-2

POSITION WANTED—Young man wishes position as oiler or assistant engineer in a plant in New York City. Two years' practical experience. Write William Brand, 24 Locust Hill Ave., Yonkers, N. Y. 10-1-2

POSITION WANTED—As master mechanic, superintendant, chief engineer or erecting engineer. Have practical and technical experience in designing, erecting and operating central stations, power transmission and distributing systems, refrigerating and ice making plants and saw mills. For years connected with the largest machinery importing and engineering house in the Orient as estimator, selling and erecting engineer. Have traveled extensively, both in the Orient and Latin Americas. Know the Spanish and Italian languages. Have executive ability and can produce results. Will accept position to go anywhere for party offering proper inducements. Box 451, Practical Engineer, 537 S. Dearborn St., Chicago, Ill. 10-1-2

POSITION WANTED—Chief engineer, experienced on Steam Turbines and Condensers, Corliss and Automatic Engines, A.C. and D.C. Generators, Transformers and Meters. Have built and operated plants with my own capital. Have liberty in 30 days or before if necessary. Will come on one Ohio First Class Engineer's license Issue No. 6. Will be at month's trial to prove my ability. Age 30. Address J. A. Wise, Mowrystown, Ohio. 10-15-1

POSITION WANTED—I am a thoroughly competent power plant engineer, accustomed to handling on high efficiency basis all types of steam engines and turbines, A.C. and D.C. machines; strictly sober; 34 years old, married. Want charge of good plant in Chicago that will pay at least $25.00 per week. Address Box 455, Practical Engineer, 537 S. Dearborn St., Chicago. 10-15-1

STEAMFITTER—Accustomed to high pressure work wants permanent situation. American and strictly sober always; am not afraid of plenty of work. Can work from blue prints, as well as do all kinds of general repairs. Have some experience in millwright work and some knowledge of steam engineering. H. L. Simonds, Box 166, Sac City, Iowa.

POSITION WANTED—Young, sober and reliable married man, as engineer. Six years' experience with A.C. and D.C. compression ice plants, Corliss, high speed and slide valve engines. Ambitious. Desire change where advancement is possible. Open October 1st. R. Bruce, Caruthersville, Mo. 10-15-1

POSITION WANTED—As oiler, by young man, age 21, single. Willing to accept position in any city. Address Peter Stanys, 670 W. 18th St., Chicago, Ill. 11-1-1

Help Wanted

WANTED—Refrigerating Engineer for a small plant, 20 ton steam driven compressor, 5 ton ice tank, several cold storage rooms. State salary wanted. Middle aged man preferred. Address Box 460, Practical Engineer, 537 S. Dearborn St., Chicago, Ill. 11-15-1

WANTED—Resident subscription agents in the following cities: Atlanta, Ga.; Cincinnati and Columbus, Ohio; Kansas City, Mo.; Los Angeles, Cal.; Louisville, Ky.; Newark, N. J.; New Orleans, La.; Portland, Ore.; St. Louis, Mo.; San Francisco, Cal.; Washington, D. C. This is an excellent chance for a hustler who is familiar with power plant conditions, to turn his spare time into dollars. To such a one we offer a Real Opportunity. Write Subscription Department, Practical Engineer, 537 S. Dearborn St., Chicago, Ill. tf.

Wanted

FOUR COPIES of Practical Engineer for February, 1910, in good condition, we will extend your subscription for three months. Circulation Department, Practical Engineer, 537 S. Dearborn St., Chicago, Ill.

WANTED—One 75 to 100 kw. Direct Current, 110 or 3 wire 220 volt, Crocker-Wheeler or Westinghouse preferred, Dynamo, direct connected to a good high speed engine. The foregoing outfit to be furnished with switchboard outfit complete with circuit breaker. The outfit must be in good operating condition and guaranteed against mechanical and electrical defects. Quote immediately best price, giving full information, size of pulley, speed, make and switchboard equipment, and if with Force Feed Oiling System. J. S. Young & Company, Hanover, York County Pa. 11-15-1

WANTED—Agents handling engine and boiler room specialties in every section for side line paying large commissions. Give experience, line carried and territory covered. Box 381, Practical Engineer, 537 S. Dearborn St., Chicago, Ill. tf.

WANTED—Well versed boiler and combustion salesman or established engineering agents to sell complete line of mechanical stokers, natural and forced draft; also steam jet ash handling system, on liberal commission lines. Box 453, Practical Engineer, 537 S. Dearborn St., Chicago, Ill. 10-1-4

WANTED—Agents on commission to sell our shaking grates. We will install grates on trial or put it on test at our expense with any grate made. Address Armstrong Mfg. Co., Springfield, Ohio.

For Sale

FOR SALE—1 72-hp. Erie City High Speed 325 r.p.m. Automatic Engine; 2 boilers, 1 steam feed pump, one injector, 1 iron water tank. Zoar Battery Co., Zoar, Ohio. tf.

FOR SALE—One 11x12 Atlas Steam Engine, 40 hp.; one 7x10 Atlas Steam Engine, 20 hp.; one 4½ K.W. D.C. Generator, 125 Volt Current; one Cook Deep Well Pump (steam driven); two Boiler Feed Pumps. All in good condition. The Gray & White Co., Tiffin, Ohio. 11-15-1

GAS ENGINE FOR SALE—One 15-hp. 2-cylinder Westinghouse gas engine for sale in good condition. No reasonable offer refused. Correspond with E. B. Latham & Co., 4 Murray St., New York City. 10-15-6

Patents and Patent Attorneys

PATENTS THAT PROTECT AND PAY—Advice and books free. High references. Best results. Promptness assured. Send sketch for model for search. WATSON E. COLEMAN, Patent Lawyer, 624 F St., N. W., Washington, D. C. tf.

PATENTS—C. L. Parker, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the invention. Handbook for inventors sent upon request. Washington, D. C. tf.

PATENTS—H. W. T. Jenner, Patent Attorney and Mechanical Expert, 606 F St., Washington, D. C. Established 1883. I make a free examination and report if a patent can be had, and the exact costs. Send for full information. tf.

A. P. CONNOR, Consulting Electrical and Mechanical Engineer, Attorney-at-Law and Solicitor of Patents and Trade-Marks. Results guaranteed. 121 Carroll St., S. E., Washington, D. C. tf.-x.

PATENTS—Send sketch for free search and reports. Books and patents and book of reference letters sent free. John S. Duffie & Co., 612 F St., Washington, D. C. tf.

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Sparks From The Advertising Pages

Practical Engineer has often made public its attitude regarding advertising of questionable character, so that it may assure its readers absolute safety in buying the products advertised in its business section and its advertisers absolute assurance that their announcements will be in the "right company." The advertisers' and subscribers' trust in this policy cannot be violated.

This censorship is not maintained to "parade our virtues." It is reiterated from time to time for the good of the constituency. In a short editorial referring to this subject, entitled, "Why Overlook Such a Talking Point," the editor of Associated Advertising says:

"It is extremely difficult to sympathize with the criticism, occasionally heard, that this or that publisher who excludes undesirable advertisements and advertises this fact, is 'parading his virtues.'

If such a publisher fails to let advertisers and prospective advertisers know what he has done, he is overlooking an excellent talking point. He is not fair to himself.

Usually, such criticisms come from publishers who have not, themselves, 'cleaned up.'

To this there are exceptions. There is room, of course, for a difference of opinion as to the amount of advertising capital a publisher should make of this point. It could be overdone.

The fact this is one of the talking points for such a publication is beyond dispute, however.

In this day, the advertising columns, as well as the editorial columns, the circulation, etc., must be taken into account by the advertiser, and the publisher who fails to call attention to his advertising censorship and to describe its nature fully and honestly, is overlooking a forceful and perfectly proper argument.

The more the publishers who are entitled to such an advantage advertise this fact, the sooner will all publications find clean columns more profitable, for the desirability of censorship will impress itself more and more forcibly upon the mind of the man who pays for the space.

The publisher who excludes undesirable copy and does not tell advertisers about it, could with as much reason, add a considerable number of desirable subscribers and keep the addition a secret. If a publisher who does not let people know what he is doing along this line, finds that additional desirable business has not been created to take the place of that which he has declined, he will have himself to blame, chiefly; for experience seems to indicate that if proper capital is made of the exclusion of undesirables, desirable copy to take its place will be forthcoming."